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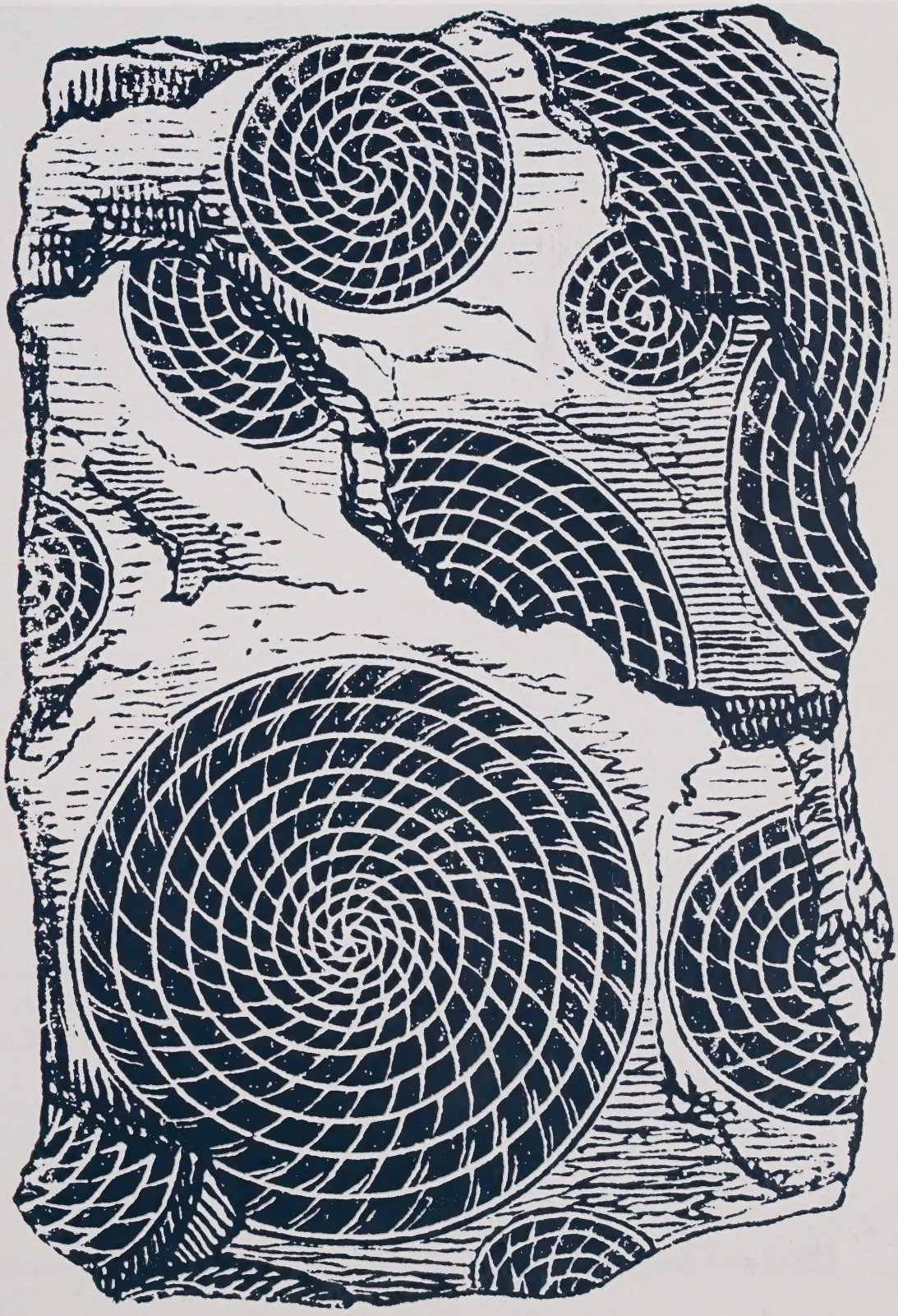

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COVER
An 18th-century sketch of a nummulite
The study of these coin-shaped fossils on the Giza plateau may reveal the building sequence of the pyramids, temples, and Sphinx. To find out more about nummulites turn to page 12. *Reproduced from volume one of the* Handbuch der Palaeontologie *by K. A. Zittel.*

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EDITOR'S NOTE

WE WELCOME YOU TO FALL with an issue of *Rotunda* that presents dramatic discoveries, theatrical restorations, an overwhelming view of nature, and an insightful look at a little-know chapter in Canadian Indian history.

The very eye-catching abstract design on the cover is an 18th-century drawing of the fossil remains of nummulites, small coin-shaped animals that lived more than 50 million years ago in the Tethys Sea. This sea covered a good portion of the northern hemisphere, including what is now the Giza plateau of Egypt. Margaret Sears of Yale University describes the work of Thomas Aigner, a German geologist, who has been studying the nummulites of Giza. He has noted that the shell patterns of nummulites changed with varying environments, and he speculates that a very accurate building sequence for the Sphinx, pyramids, and other monuments of Giza might be determined by matching like nummulites in the millions of building blocks.

What could be more different from fossils in desert sands than what we have called Scotland's Garden Quartet, the sites that make up the colourful and exotic Royal Botanic Garden, Edinburgh. John McNeill, associate director-curatorial at the ROM and former Regius Keeper of the Royal Botanic Garden, Edinburgh, writes about the history of the gardens in which plants from all over the world (including deserts) are grown, and where internationally acclaimed botanical research is conducted.

From deserts and gardens we turn to the cooling pond of the Braidwood Nuclear Power Station in Illinois, the location for Desmond Collins's article about Pit Eleven monsters. Pit Eleven, the cooling pond, was formerly a coal mine. In it collectors have found a remarkably varied fossil fauna of animals with names such as "Tully monsters" and "blobs" that lived underwater 300 million years ago. The discovery of this fauna has proved extremely important to the understanding of evolution, and the ROM has been very fortunate to acquire an excellent Pit Eleven collection. Collins, a curator of invertebrate palaeontology at the ROM, is best known for his research on another remarkable fauna, that of B.C.'s Burgess Shale.

Douglas Fetherling, a keen observer of Canadian culture, takes an indoor look at a relationship that has developed with the restoration of Toronto's Pantages, Elgin, and Winter Garden theatres. The three theatres, once thriving vaudeville houses, had fallen on very hard times. With a great deal of dedication and imagination, it was decided to restore the theatres to their original splendour. As a result, Toronto has new venues for popular shows such as *Cats*, and in turn, the financial success of these ventures not only has justified the restorations but has resulted in the recreation of a vibrant theatre district.

The focus of the last feature is on people. Donald Smith, a professor of history at the University of Calgary, writes about a conference on the status of Indians held at the Museum in September 1939, to which native people, for the first time, were invited as delegates. It unexpectedly turned into a clear message to the native delegates about the importance of self-reliance.

Sandra Shaul

SANDRA SHAUL

Florence. Home of the Italian Renaissance. Yesterday's, today's and tomorrow's. Photo: Peter Christopher.

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Portrait of Margaret Sutherland, *1792, by François Malepart de Beaucourt, oil on canvas, 81.8 cm x 61.4 cm, inscribed, F .·. Beaucourt .·. pinxit / A Montreal .·. 1792. Canadian Decorative Arts Department, Royal Ontario Museum. Gift of the Jeanne T. Costello Trust and of Mr. William J. C. White, Q.C.*

The ROM acquires a rare early Canadian portrait

ONCE IN A LONG WHILE A PREVIOUSLY unknown treasure of early Canadian painting comes to light. Recently such a painting was acquired by the Canadian Decorative Arts Department of the Royal Ontario Museum, a gift of the Jeanne T. Costello Trust and of William J. C. White, Q.C. It is a portrait of Margaret Sutherland painted in Montreal in 1792 by François Malepart de Beaucourt (1740-1794).

François Beaucourt has been described as the first native-born Canadian to achieve real distinction as an artist. Paintings by Beaucourt are rare because he spent most of his career in France, only returning to Montreal in 1792, two years be-

fore his death. His seven known portraits are considered treasures of Canadian art, displaying a combination of elegance and naiveté, which creates a decorative realism that lends a lively charm to the subjects .

The signed and dated portrait of Margaret Sutherland had remained with her descendants until its donation to the ROM. It is in remarkably good condition, with the paint layers apparently in their original state.

Margaret Sutherland was the daughter of Marie-Louise Réaume and of Colonel Daniel Robertson of Montreal, an officer, landowner, and for many years commandant at Michilimackinac in Upper Canada. In 1781 Margaret Robertson married Daniel Sutherland (1756?-1832), a Montreal merchant who, at the time the portrait was painted, had become a shareholder in the North West Company of fur traders. On 1 September 1831 they celebrated their 50th wedding anniversary, an occasion which Daniel commemorated with the striking of a gold wedding medal.

The portrait and its attributes convey the style of life in a prosperous merchant's house in Montreal of the late 18th century. A young woman, seated at a Regency-style mahogany desk, pauses in her task of letter-writing to gaze past the viewer with a pensive half-smile. Her ormolu-mounted malachite writing set is before her. The woman's costume is simple and elegant; she is dressed in white with the exception of the wide sash and a pink ribbon in her elaborate head-dress. From her waist hangs a chatelaine with pearl tassels, which holds her gold-cased watch.

The portrait is now displayed in the Canadiana galleries in the ROM's main building. From October 1991 it will be part of the exhibition *Passages: The Art of Painting in Quebec*, organized by the Musée de Québec.

Mary Allodi, curator in the Canadian Decorative Arts Department, Royal Ontario Museum

PHOTOGRAPHY COURTESY OF GERALDINE RUBINO

***Balsamic vinegar,* aceto balsamico, *is made in a battery of wooden casks, which are kept in a room called an* acetaia.**

Aceto Balsamico, Precious Vinegar

BALSAMIC VINEGAR, SO NAMED BECAUSE it possesses the odorous qualities of balsam, has been made with loving care by generations of families in certain parts of Italy. Having a well-kept *acetaia*, a place where vinegar is made, was once a source of pride and an aristocratic tradition linked to the possession of lands and vineyards. The earliest written reference to balsamic vinegar (*aceto balsamico*) dates from 1046 when Count Bonifacio di Canossa (father of Matilda, the Great Countess of Tuscany) presented a barrel of it to the Emperor Henry III as a coronation gift. No ordinary keg was deemed worthy to transport such a precious liquid, and so the count had a special one made, decorated with repoussé designs in silver. A cart drawn by two white oxen delivered the Emperor's gift.

By the 16th century balsamic vinegar was considered so valuable a commodity that it was disposed of specifically by will and considered one of the more important kinds of bequest. In 1944 when American bombers approached Modena, Italy, one of the historical production areas of balsamic vinegar, many inhabitants took to their bicycles to escape with small kegs of the vinegar securely strapped on luggage carriers. After the war the product faced extinction, but recently there has been renewed interest as commercial versions have become more accessible on world markets. A few remaining artisans continue to make the traditional balsamic vinegar and a consortium has been formed to defend the image of the precious liquid.

Two regions in Italy, Modena and Reggio Emilia, are famous for producing the classic vinegar, gleaming dark brown in colour, penetrating and persistent in aroma, with a tart yet sweet flavour. The long process begins with the non-fermented must of Trebbiano grapes which is condensed slowly over an open fire until it reaches about one-third of its original quantity. The liquid is then poured into the first of a series of casks called a battery. Each battery consists of five or six casks ranging from 60 litres to 10 litres in capacity, each constructed of a different wood. The slow acetification process is usually started in red oak, with encouragement from a vinegar mother (a starter batch) that is at least ten years old. As the vinegar ages, it is transferred from oak to chestnut to cherrywood to ash to mulberry and sometimes

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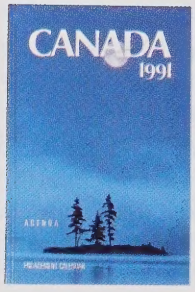

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to locust or juniper. Each wood adds new fragrances or nuances of flavour and each is used to achieve a particular style to suit its creator.

The barrels are generally housed in an *acetaia* located just under the roof of the building designated for vinegar production, with the bunghole facing upward and covered with a flat slab of stone or (more common nowadays) a piece of cheesecloth. Over a great length of time (a minimum of 12 years, more often 20 or 30 years), the effects of changing conditions from winter chill to summer heat combine with the ancient process of decanting and topping up from barrel to barrel to create a very special condiment. Vinegars produced in this traditional way are in the minority —only ten thousand small bottles annually compared to five million bottles from industrial production. Competition from the industrial vinegar, a combination of ordinary wine vinegar with some aromatic potion, is not viewed as a serious problem by the artisans. Since it is priced to make it more accessible to the general public, more people will be encouraged to try balsamic vinegar and from there to move on to discover the traditionally produced essences from Modena and Reggio Emilia.

Balsamic vinegar was originally used for medicinal purposes. Its therapeutic qualities were praised in treating throat infections, excess stomach acidity, lack of appetite, and scurvy. Now this vinegar is used more widely in gastronomy.

As a flavouring agent, balsamic vinegar must be used sparingly; some producers recommend half a teaspoon per person as a rule of thumb. It should not be used during the cooking process but should always be added to hot food just before serving. It heightens natural flavours in soups, stews, and sauces but, in my experience, it causes its most dramatic effect in salads and it does not obliterate your glass of chilled white wine as most vinaigrette dressings do. In fact balsamic

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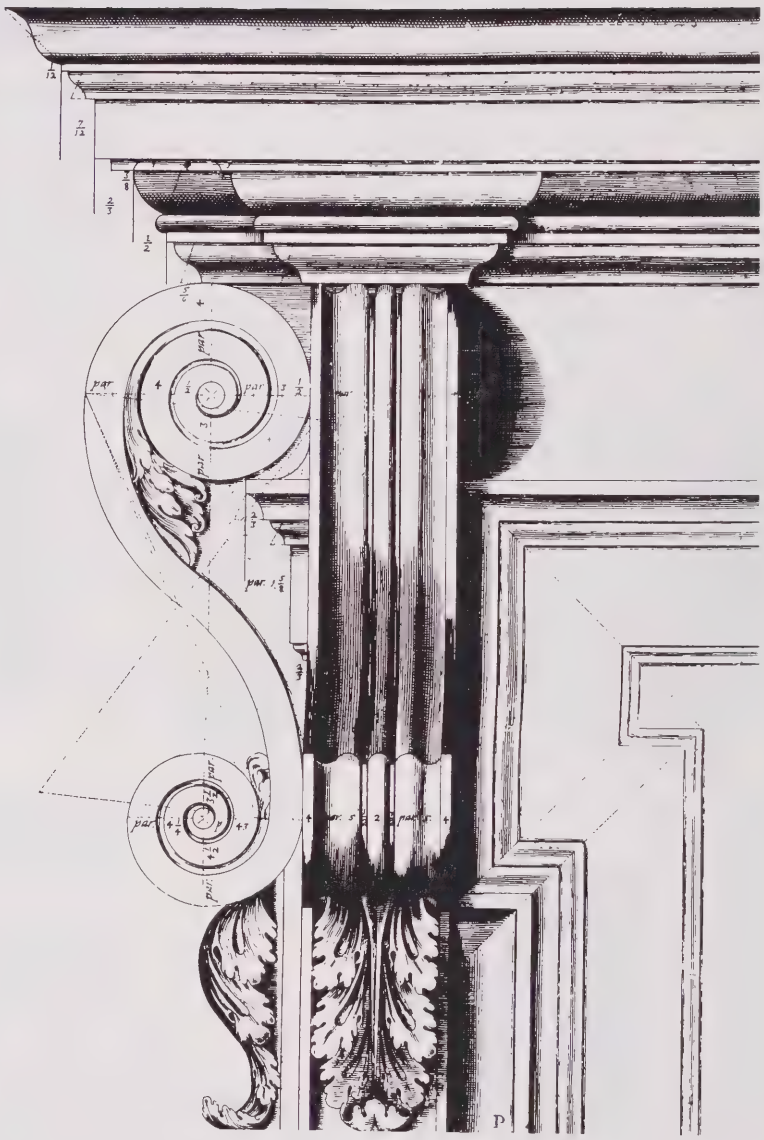

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vinegar is greatly appreciated for its compatibility with accompanying wines.

Now that garden greens and fruit are at their best, here are some recipes to try. Place the required quantity of mixed greens, including arugola (sometimes known in North America as rocket), in a bowl together with flakes of Parmigiano-Reggiano cheese. Add salt and freshly ground pepper to taste together with balsamic vinegar and good quality olive oil, and mix. Simple becomes glorious.

Tomatoes and balsamic vinegar have an affinity made in heaven. Skin and seed three ripe tomatoes, then cut them into strips. Slice three zucchini into strips and parboil. Combine the tomatoes and zucchini strips with coarsely chopped basil leaves, balsamic vinegar, extra virgin olive oil, salt and pepper, and serve on a bed of lettuce.

For tomato sauce with a difference, start by making basic tomato sauce using fresh tomatoes or canned Italian plum tomatoes. Season with salt and pepper. Just before serving add 30 mL coarsely chopped basil leaves, 2.5 mL finely chopped garlic, 15 mL capers and 5 mL balsamic vinegar per person.

A special treat in Italy is strawberries flavoured with balsamic vinegar and sugar. Whole or sliced strawberries are placed in a bowl with two or three spoonfuls of balsamic vinegar. After the berries have marinated for about 15 minutes, sugar is added to taste and then the berries are mixed thoroughly and served.

Even if relief from scurvy is not uppermost in your mind, you should try this vinegar to see if it deserves the adulation it is once more receiving. Start with the semi-precious and progress to the traditional *aceto balsamico*. The traditional product may be costly, but then the dedicated work of artisans is never inexpensive nor should it be.

GERALDINE RUBINO
Geraldine Rubino is a Toronto-based freelance writer on wine.

NUMMULITES: TIME CAPSULES OF THE DESERT SANDS

Small coin-shaped fossils are revealing the secrets of the Sphinx's environment

MARGARET SEARS

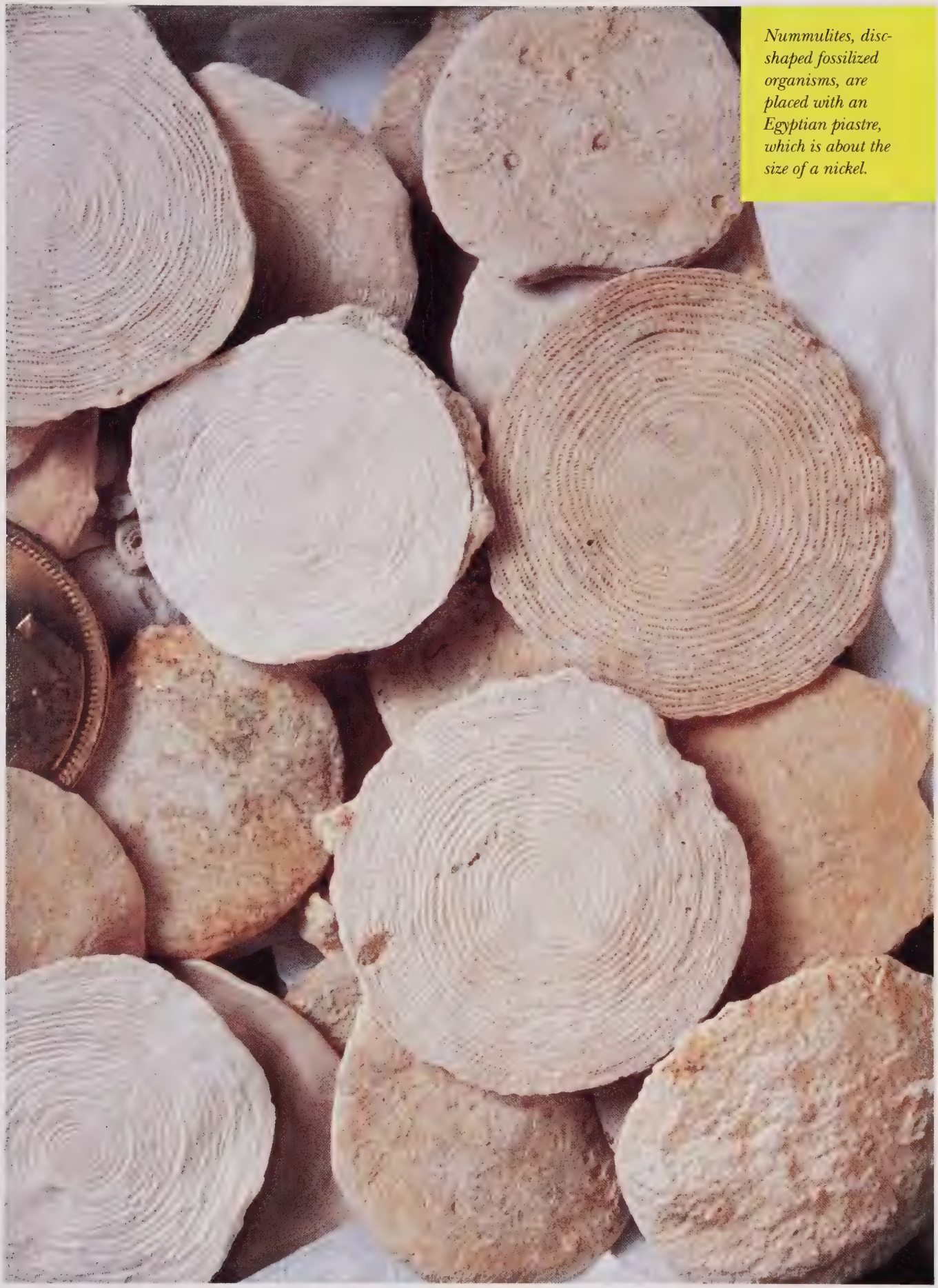
TENS OF THOUSANDS OF TOURISTS EACH YEAR VISIT THE Giza plateau in Egypt and walk the sandy desert, while gazing up at the pyramids and other monuments at the vast necropolis. But most of them will never notice some extremely ancient objects that lie just beneath their feet. These items are not the kind one normally associates with the ancient Egyptian civilization; they are not buried monuments, or lost inscriptions, or even bits of broken pottery left over from the third millennium B.C., although such treasures are there for archaeologists to find. They are far older and are scattered all over the plateau, packed in the sand and limestone surface, right there amid the discarded, rusting Pepsi-Cola bottle tops and bits of foil gum wrappers. These treasures are small fossilized discs. In bunches they look like a fistful of pocket change. No wonder, then, that they are called nummulites, after the Latin *nummus* for "coin."

Strabo, the Greek geographer, found nummulites during his trip to Egypt in the 1st century A.D. His *Geography* records that "heaps of stone chips lying in front of the pyramids" were reportedly the petrified remains of lentils left behind by the pyramid builders. Indeed, some nummulites look like lentils, but they are often much larger than that, up to the size of a quarter. Strabo could not have known that each nummulite is really a tiny natural time capsule from an era only several million years after the dinosaurs last roamed the Earth, when the Giza plateau was a steamy, subtropical lagoon teaming with marine life.

Nummulites are petrified unicellular planktonic organisms that lived in the waters of an Eocene sea that covered much of Egypt and northeastern Africa 50 million years ago. They proliferated in a tropical environment, warm and rich in algae and other nutrient sea life, and lived near the bottom of the seas. As nummulites died, their shells, known as tests, collected in large quantities on the sea floor, often in banks. Over time the nummulite tests, along with other shells and debris, became part of the sediments that solidified into the limestone layers of the Giza plateau, where the pyramids now stand.

Today, these unassuming-looking fossils are important not just as curiosities. Nummulites provide vital clues to palaeontologists and scientists in other fields about life many millions of years ago, for which little other evidence exists. They even play a scientific and commercial role that few people would suspect. Geologists who advise the petroleum industry have known for years that the

Margaret Sears has an M.A. in Near Eastern Studies from Princeton University. She served as the United States coordinator for the Giza Plateau Mapping Project and has been the project photographer since 1984. Her most recent contribution to Rotunda *is "Who Built the Great Pyramid of Egypt?" featured in the spring 1990 issue.*

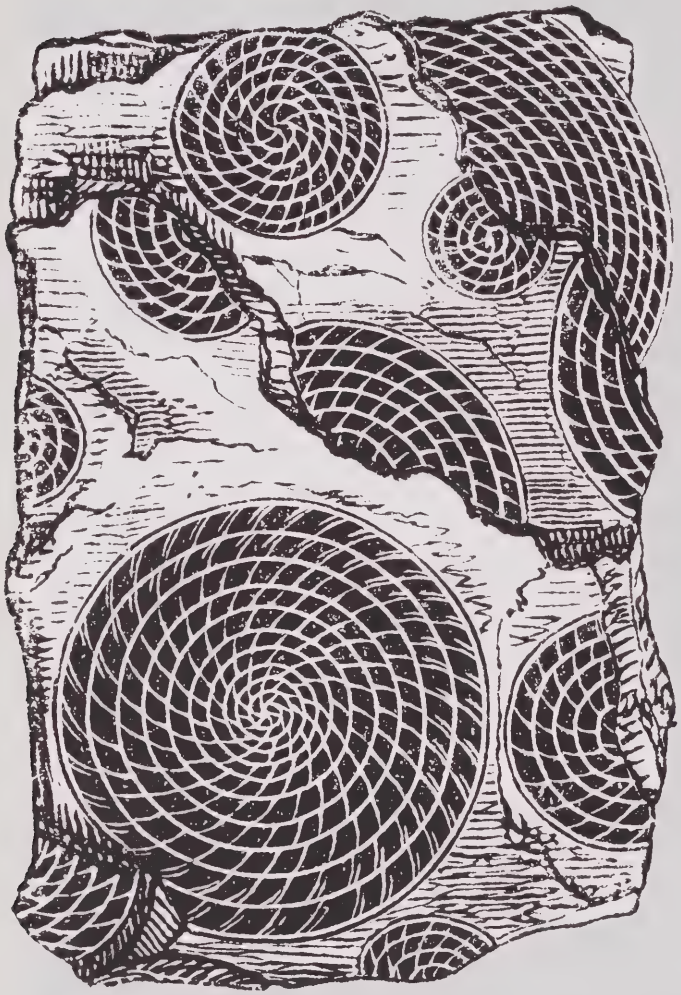


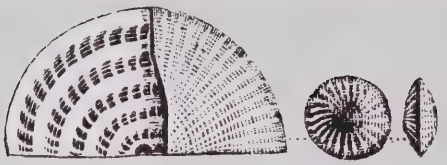
Nummulites, disc-shaped fossilized organisms, are placed with an Egyptian piastre, which is about the size of a nickel.

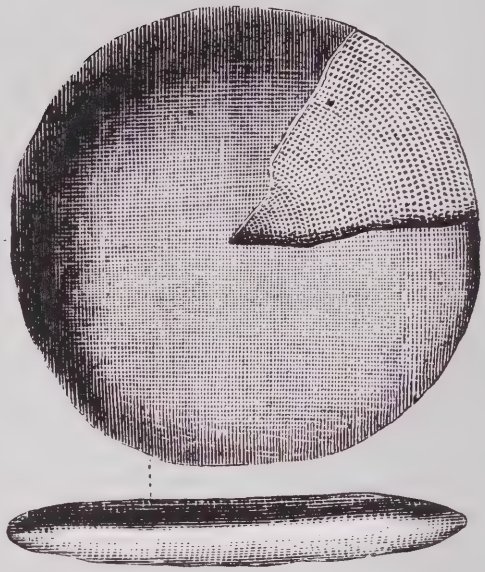
PHOTOGRAPHY BY BILL SACCO, PEABODY MUSEUM, YALE UNIVERSITY

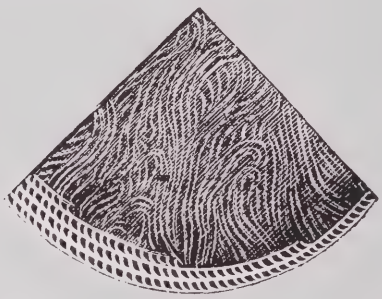
Nummulites from North Africa and France

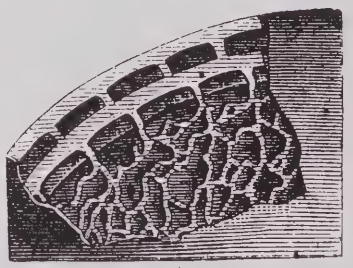
The sketches of nummulites are from volume one of the 18th-century Handbuch der Palaeontologie *by K. A. Zittel. The different forms of nummulites can reveal important aspects of the ancient environments in which they lived.*

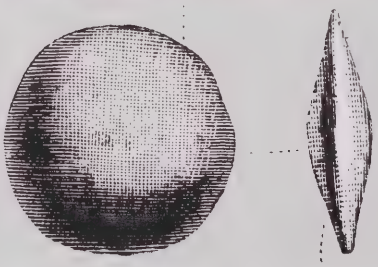












Above: Nummulites in limestone from the Pyrenees Mountains are shown from a horizontal section.
Right: (Top) Three views of a Pyrenees nummulite;
(Middle) Three views of a Nummulites Gizehensis *from the Libyan Desert;*
(Bottom) Three views of a nummulite from the Paris basin.

presence of nummulites in limestone may lead them to oil. In Egypt, where geologists have long known that nummulites are a basic component of the limestone strata of the Giza plateau, the in-depth study of these fossils has helped to explain not only how the plateau was formed, but also how sediments at Giza correlate to sediments that took shape at the same time in other parts of the Mediterranean and in Europe.

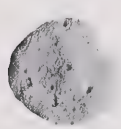
Archaeologists and geologists have long worked together on research at a number of sites throughout the world. This collaboration has spawned a new subdiscipline: geoarchaeology. Geoarchaeological analysis applied to ancient monuments, such as those in Egypt, not only has the potential to yield new information about the monuments themselves but may also help archaeologists to better appreciate what the ancient Egyptian engineers must have known about the geology and suitability of the plateau as a building site when they undertook the work.

At Giza, archaeologists are finding that the hard-shelled fossils may help to explain why certain strata of limestone were used by the ancient Egyptians in the construction of monuments such as the Sphinx and the pyramids.

Thomas Aigner, a young West German geologist who has specialized in the study of nummulites at Giza, is giving archaeologists a new understanding of the site. They are learning that the nummulites themselves, along with their fossilized sea-bed companions like oysters, gastropods, and sponges, can serve as key index fossils in identifying and tracing multi-tonne blocks of stone back to the quarries from which they were cut. This sort of fossil-sleuthing may make it possible someday to reconstruct the actual building sequence of many of the temples on the plateau, and even that of the 2.3 million limestone blocks that were used to build the Great Pyramid of Cheops. Already, Aigner's findings may have set the stage for unravelling the construction sequence of the Sphinx and its adjoining temples.

It may be possible to reconstruct the whole building sequence of the pyramids, the temples, and the Sphinx on the Giza plateau through study of the nummulites found there

So far Aigner is the only geologist to have concentrated research specifically on the monuments of Giza and the local species of nummulite called *Nummulites gizehensis*. But nummulites are not unique to Egypt. Members of this scientific group, mostly of microscopic dimensions, are found in limestone and sandstone deposits on every continent and every sea floor throughout the globe. The shells of millions of organisms of their class, *Foraminifera*, make up the chalky-white ooze that covers 50 to 80 per cent of the floors of the world's great oceans.



Nummulites found on the Giza plateau are unusual because of their large size. Large nummulites seem to have occurred only twice in geological history: first during the Permian Period 280 million years ago, and then in the Tertiary Era, which comprised the Paleocene, Eocene, and Oligocene periods, between 65 and 35 million years ago. Palaeontologists believe that symbiotic algae lived in the nummulites, and that these, along with favourable temperatures and salinity, were the main reasons that these nummulites became so large.

Nummulites thrived in warm, shallow marine water, where they floated passively or clustered at the bottom. When alive, the nummulites' tests were probably opaque white, which under light gave them a porcelainlike appearance. Today, whole nummulite fossils are sand-coloured and have the shape of tiny flying saucers: each is a small disc with two smooth sides that are slightly raised at the centre and then flatten out towards the edges.

To picture the interior structure of the nummulite disc, one might think of the great chambered nautilus. The spiralled nautilus shell is composed of a series of successively larger separate chambers that are formed in an outward, coiling direction by secretions as the mollusc grows. The nummulites at Giza grew in much the same manner, only more primitively, as their microscopic descendants still do today. The nummulite test was formed as the living single-celled organism—basically a cell membrane filled with protoplasm—secreted calcium carbonate around itself to form a protective cover. Initially this test was a single, simple chamber. But as the organism grew, it secreted more calcium carbonate and new chambers were formed in an outward coiling direction, each coil completely enveloping the previous one. A small opening in the chamber wall connected one chamber to another and the protoplasm extended back through all of the chambers. At the outside chamber the protoplasm formed a whiplike extension, called a pseudopod, that the nummulite used to move and to capture other organisms, such as diatoms, for nourishment. As the organism inhabited the outer chambers, the central chambers were filled with a secondary growth of calcium carbonate.

The spiral shell pattern of the nummulite can be seen most clearly when the nummulite disc is split into two halves on an axis. The interior plane of the nummulite looks like a miniature phonograph record—the spiral, chambered grooves re-

The Sphinx:
A Monumental Carving from the Ancient World

The world-famous Sphinx of the Giza plateau was carved from one core of stone, possibly a huge block. It stands in the remains of the quarry from which stone blocks were extracted by Egyptian workmen to build the pyramids and temples of Cheops, Chephren, and the Sphinx.

PHOTOGRAPHY COURTESY CENTRE WLADMIR GOLENISCHEFT

PHOTOGRAPHY BY MARK LEHNER

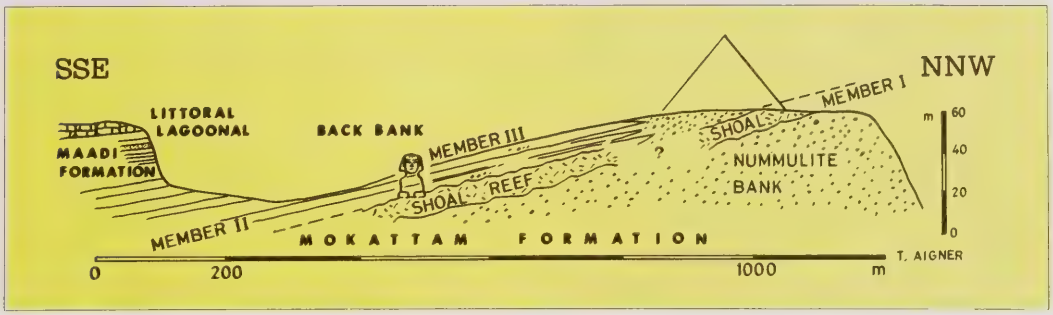
This coral remains in its original life position in the fossilized reef found in the walls of the ditch where the Sphinx sits.

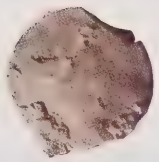
PHOTOGRAPHY BY BILL SACCO, PEABODY MUSEUM, YALE UNIVERSITY

Top left: Rocks taken from the Giza plateau contain nummulites ranging in size from 2 millimetres to 2 centimetres.

Excavations around the Sphinx were conducted in 1925-26. They clearly revealed the different natural stone and soft clay layers in the great sculpture (left) as well as the masonry work (above) of restorations dating back to ancient Egypt.

This cross-section created by Thomas Aigner, a West German geologist studying the rock formations and nummulites of the Giza plateau, shows the remains of an environment that existed 50 million years ago and the fabulous monuments that could be built from them.





veal the steady outward growth of the organism. The chambers in the nummulite can be seen by the naked eye, but when viewed under a microscope, the gradual in-filling of the central chambers is more easily observed.

The exact composition of the test and the arrangement of the chambers is a key factor in identifying species of nummulites and distinguishing them from other similar fossils. There are literally hundreds of varieties of chamber patterns in nummulites, and an even greater variety in the world of shell-secreting organisms that make up the world's fossil record. Nummulites are a particularly significant part of this early fossil record; their great diversity is testimony to the hardiness of simple protozoans at a time when the Earth's life forms were beginning to develop more complex features.

Nummulites similar to the ones in Egypt, and from the same geological period, are found in a large proportion of the limestone beds of the Paris basin in France. Although the city of Paris covers most of the limestone embankments, visitors today can explore many of the huge subterranean quarries and caverns that produced the building materials for much of the city. And limestone blocks, cut to build Notre Dame and other magnificent structures, contain countless numbers of nummulites.

The Eocene sea, in which nummulites thrived, covered both Egypt and France and was the remnant of a much larger body of water called the Tethys Sea. Sometime during the Mesozoic Era, between 245 and 65 million years ago, that enormous ancient sea stretched from northern Africa and southern Europe to southwest India and into the East Indies. Throughout the millennia, invading seas were part of a long cycle of inundation and retreat that helped to create the continents.

During the course of the 30 million years following the Mesozoic, upward-moving tectonic forces in the Earth's crust lifted the northeast corner of the African continent, causing the waters of the Tethys Sea to recede to the Mediterranean Sea. The retreating waters deposited extensive layers of muds and silts on top of a series of compressed folds of limestone—shale and clay from the earlier Cretaceous Period—to form the Egyptian tableland. In the waters that were slowly edging northwards, a nummulite colony thrived on one of the submarine mounds of the Cretaceous. Over time, probably blown and sorted by storm waves, millions of nummulite tests from the colony began to bank up exactly where the three Giza pyramids sit today.

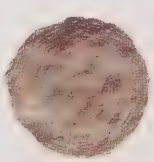
In the shallows left by the retreating waters, a coral reef developed on the southeastern slope of the nummulite embankment, much like a reef that one might find in the Caribbean today. The reef formed a natural barrier to the shoreline and it became a haven for a rich panoply of sea life: coral colonies, shell-encrusted algae, sponges, and oysters. In time, the waters retreated farther still, and the water behind the coral reef became a large shallow lagoon. Protected by the reef from swift currents and waves, the marine deposits in the lagoon accumulated in a regular sequence of soft clay and hard limestone layers. Conditions in the waters, which were increasingly brackish, did not favour the growth of large numbers of planktonic organisms. Later, the lagoon became stagnant and the waters slowly evaporated. Much later, the Nile river valley formed when heavy rains sent fresh torrents of water over the tableland. The ancestor river to the Nile cut a series of steep escarpments and cliffs along a canyon that extended from Upper Egypt to the Giza plateau in the north. Later still, during the annual inundation of the Nile, the waters at Giza came close to the base of the plateau, but the broad limestone Mokkotam Formation, on which the monuments of Giza would be built, remained above the water, dominating the plain.

The geological features of the Giza plateau help to explain how the ancient Egyptians organized the site for building their monuments around 2600 B.C.

The geological features of the plateau help to explain how the ancient Egyptians organized the site for building their monuments around 2600 B.C. The Giza plateau slopes gently from its highest point at the northwest, to the west of the pyramid of Cheops, down to the southeast, at approximately the location of the Sphinx.

Slightly farther down the plateau to the southeast, the hard nummulitic limestone gives way to an alternating sequence of soft and hard bands of rock. Here, in what constitutes the geological remains of the great lagoon behind the coral reef, the Egyptians found an ideal quarry. By cutting the soft bands that occurred in regular intervals, the ancient quarrymen could take the harder layers in between and easily shape them into large building blocks. They then dragged the blocks up the slope to the site of the pyramid.

The use of the plateau in this extremely calculated manner suggests that the ancient Egyptians were very keen observers of their environment. While they could not have understood how the plateau was formed in the way that modern geologists do, they did have a good grasp of the stratigraphic makeup of the plateau, and they used their knowledge in an intelligent manner over the course of three generations, as they constructed



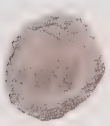
one great pyramid complex after another.

Their skill in shaping the natural rock is especially noticeable with the Sphinx. Guardian of the plateau at the very base of the slope of the Mokkotam Formation, the Sphinx lies in the area of the quarry that the Egyptians used for the pyramids and temples of Cheops and Chephren. In fact, the Sphinx is situated in a ditch carved deeply into the layers of alternating limestone and soft clay laid down by the Eocene lagoon. The quarrymen removed enough stone along the soft bands to expose the natural contours of the fossilized coral reef. This established a hard base for the colossal statue. In the middle of the quarry ditch, they left a core of stone, possibly in the form of a large block, which they reserved for sculpting the famous lion body with the pharaonic head.

The Sphinx is, therefore, a core sample of the three principal groups of rock layers in the plateau, and these layers are much like a great rock sandwich. The lowest group is composed of the hard coral reef that grew on top of the nummulite embankment. Here, even today, it is possible to see corals in life position in the walls of the ditch, along with other fossils, like oysters and sponges.

Most of the statue's torso is carved from the middle lagoonal layers, which now appear as badly weathered alternating bands. The upper parts of the Sphinx—the back, neck, and head—are composed of the upper group of layers which are much harder than those of the torso. The head is limestone that appears to have been good for carving, yet was able to withstand the ravages of winds and sand over time. The upper Sphinx stone contains an abundance of another fossil called *Operculina*, which looks like a small spiral. These fossils are actually the calcified, compressed, and solidified remains of the trap doors of small snails and fish gills.

The Valley Temple of the Chephren Pyramid and another large temple built for the worship of the Sphinx stand below the statue's outstretched paws on a flat terrace about 2.5 metres lower than the floor of the monument itself. These temples were built out of huge blocks of limestone, weighing up to hundreds of tonnes, that dwarf even those that were used for the pyramids. They are called core blocks, because they form the core of the temple walls, which were later sheathed with red granite from Aswan in the south of Egypt. The use of core blocks in this type of construction appears to have taken place only at Giza, and the reason has a lot to do with the ancient lagoon, which allowed the quarrymen to take broad cuts of stone by simply incorporating more layers of alternating sediment in a given block.



The core blocks that comprise the walls of the Sphinx Temple are so large that they contain up to three geological layers, and in many places in the temple walls, the geological layers run continuously from once block to another without interruption, just as they did in the quarry site. This continous pattern suggests that the blocks were taken in order from a quarry to the wall. The layers in the core blocks are also similar to the layers in the Sphinx. This may mean that these huge blocks could be traced back to their original position in the quarry where the Sphinx was created.

Once again the nummulites and their sea-floor companions prove useful. Some of those creatures are familiar animals with strange names: echinoids (sea urchins), serpulids (worms), and *Ostrea phranois* (oysters). Starfishes and crabs are also preserved along with the petrified burrows of some of these animals. The approach of Thomas Aigner's research has been to analyze and record the abundance and variety of fossil life in the exposed layers of the Sphinx. Aigner then compares this data to that of the core blocks in the temples in front of the Sphinx. Through this method, he has determined that the Sphinx and temples were built as part of the same process. His preliminary work suggests that the blocks of the Valley Temple were constructed from layers that are characteristic of the head, neck, and shoulders of the statue, while the blocks in the Sphinx Temple were cut from deeper layers that resemble the lower body of the Sphinx.

Adding the study of nummulites to the study of geological layers in the core building blocks at Giza may make it possible to more accurately determine the original placement of the stones in the quarry

Aigner has suggested the possibility that close analysis of nummulites themselves may make it possible to fix the original placement of these stones in the quarry with greater accuracy. Because changes in their ancient marine environment caused these nummulites to display such variety in their coil patterns, it may be possible to trace a nummulite pattern particular to each stratigraphic layer and to permit a finer tuning of the analysis of the multi-tonne blocks.

This, of course, would have intriguing implications for the archaeology of the site. Imagine the challenge in store should it become possible to apply this kind of study to the 7 to 8 million blocks that make up the pyramids, not to mention the rest of the necropolis. It seems ironic that nummulites, organisms 50 million years old, can provide clues that may help us to unravel how the Egyptians—a mere 5000 years ago—transformed and sculpted the plateau into one of the world's most ambitious construction sites.

Toronto's Theatres Reborn

The restoration of the Elgin, Winter Garden, and Pantages theatres has restored more than architecture in Toronto

Douglas Fetherling

It so happened that on 7 May 1915, when a German U-boat sank the British ship *Lusitania* with the loss of 1198 lives, Groucho Marx was appearing at Shea's theatre in Toronto. In those days he was a solo performer, quite separate from his brothers, and moreover he was a dialect comedian, specializing in fractured German. But suddenly the public's anti-German feeling, which had been prevalent enough since Britain and Canada entered the Great War the preceding August, reached a new level of intensity, and the comedian had to scramble to salvage his act. With moments to go, he switched to the loping gait, the lascivious glance, and the grease-paint moustache that soon made him famous.

A tiny anecdote, granted, but true, if one is to believe Groucho's own testimony, and one that gives a vivid glimpse into the vanished world of Toronto vaudeville. In what seems to us that impossibly innocent age in the first couple of decades of this century, before popular culture turned violent and entertainment stopped being "live," Toronto was the home not only of Shea's Victoria Street (razed in 1956) but of a number of other such theatres where the audiences were appreciative and the bills constantly changing, with an endless parade of singers, dancers, comics, and novelty turns.

The team of Smith and Dale (Joe Smith and Charlie Dale, whose partnership began when their bicycles collided on a Manhattan street in 1898) were especially popular with Toronto audiences, for example, as were Weber and Fields, to say nothing of other entertainers such as the Duncan Sisters whose fame has not lingered in quite the same way. They would play not only at Shea's but at a much larger theatre under the same ownership, the 2622-seat Hippodrome, which stood opposite Old City Hall. Near by was the Casino, which also acted as host to classic vaudeville though it was mainly a burlesque house.

Yet the city's theatre district, if it can be said that there was sufficient concentration to warrant use of the term, was one short stretch of lower Yonge Street. In vaudeville days its two landmarks were the Pantages and Loew's, the Canadian flagships of those rival impresarios, Alexander Pantages, a Greek immigrant who took part in the Klondike gold rush and opened his first theatre in Dawson, and Marcus Loew, a sort of missing link between the old actor-managers on the one hand and the Hollywood moguls on the other. Both sites are excellent examples of their kind and both have recently been restored and rejuvenated; though those terms hardly do justice to the revitalization process. To be accurate, three theatres have been so treated, for the Winter Garden, built atop Loew's, piggy-back fashion, has also been brought back

THE TORONTO TRANSIT COMMISSION

This view of Yonge Street in 1922 shows the exterior and the marquee of Loew's Yonge Street Theatre, now the Elgin.

Douglas Fetherling is literary editor of the Kingston Whig-Standard.

ONTARIO HERITAGE FOUNDATION

The Elgin Theatre is now restored to its original splendour. A production of *Cats* ran for two years in the theatre when it was partially restored, and this convinced the public of the practicality of continuing the restoration by supporting the project.

to life—in the style of the period between the First World War and the end of the 1920s boom.

The aforementioned Weber and Fields were part of the entertainment when Loew's Yonge Street was formally opened on 15 December 1913. So was Irving Berlin, who lived almost long enough to enjoy the thought of the grand reopening seventy-six years later, to the day. A ticket kiosk outside, identical to the one newly put there by a restoration team using old photographs and drawings as their guide, sold admissions ranging from five to fifty cents. The theatre in those days

was very much a mass entertainment, but what the masses demanded was opulence. The lobby had then, as it now has once again, walls covered in red damask, punctuated by *faux* marbled columns and topped with gilt cornices. As Marcus Loew, who arrived with his entourage in a private train, liked to say, "We sell tickets to theatres, not movies." Two months later, he had reason to restate the claim when the Winter Garden opened in the same building, seven storeys up. It was intended for use on weekends.

Certain types of theatrical decor seem to stay in vogue even when popular tastes in theatre are very fickle

Both theatres featured silent films as well as vaudeville, but they were as different as chalk and cheese. Loew's was large (2149 seats), ornate, and dignified, with classical references worked into the cartouche above the stage and the various other pieces of ornamentation. The smaller Winter Garden (1410 seats), which was approached by means of either the aptly named Grand Staircase or one of the three iron elevator cages, had a less traditional motif and hence a different feel. It was supposed to suggest a winter garden or at least some sort of bucolic setting. The walls and ceiling were covered with 5000 specially treated birch leaves, and pillars were encased in housings made to resemble the trunks of living trees. The entire complex was designed by Thomas W. Lamb, one of the foremost theatre architects of the day, an American who, by coincidence, would design the less ornate Pantages up the street, which opened in 1920. The Loew's/Winter Garden was his only double-decker theatre. Indeed it was one of only six or eight ever built, of which two others, both in New York, survive.

For all the difference in their personalities, the Elgin and the Winter Garden both must have been bustling, exciting places to be. George Burns and Gracie Allen played there, as did Sophie Tucker, the self-styled "last of the red-hot mamas," to say nothing of the sort of entertainers who sound no less than bizarre today. There were, for example, Siamese twins who boxed each other. There was also a man who called himself an upside-down dancer. To demonstrate his skill, he bounced down the long flights of stairs with his feet waving in the air.

Such diversions and such theatres were doomed, however, by the arrival of talking pictures, whose coming was so sudden that it caused many buildings to be shut and, in other cases, interiors to be covered up by quick renovations. The speed of the change was important. Just as a volcano or an earthquake has sometimes preserved sites for archaeologists, so did the shift in entertainment technology and new fashions in leisure have a similar effect here.

The Winter Garden saw its last weekend performance in March 1927, when radio and the cumulative impact of silent movies were already killing off vaudeville, and when talkies, in any case, were only a year or so away. Two months later, in May 1928, it had to be reopened temporarily when the downstairs theatre was swept by fire caused by an electric short in the mammoth Wurlitzer organ. At about that same time, Shea's Hippodrome was forced by declining attendance to close for a while, only to reopen with a new wave of vaudevillians, people like Red Skelton and Jack Benny, shuffled into the same bills as Burns and Allen and Ed Wynn. Business was so bad at the Pantages that it came under new management and got a new name, the Imperial.

In 1930 the Loew's organization, having closed off the Winter Garden permanently by simply sealing it up like a tomb, decided to embrace the future it feared and so converted the main theatre, soon to be called the Yonge, to movies exclusively. And in the heydays of the major studios, the policy worked well; a new generation found the Yonge as important a site as their parents had done. Throughout much of the 1930s and 1940s, the Yonge was where the big MGM musicals were shown in Toronto; the Canadian premiere of *Gone With the Wind*

THOMAS FISHER RARE BOOK LIBRARY, UNIVERSITY OF TORONTO

This photo of the Loew's Yonge Street (Elgin) and Winter Garden theatres taken in 1915 shows the vestibule with the box office, entrance doors, and stained-glass transoms.

ONTARIO HERITAGE FOUNDATION

All the magic of the original Winter Garden Theatre has been recaptured in the restoration thanks to the tireless efforts of talented historical researchers, architects, and craftspeople.

was held there, too. But as movies declined in the face of television, so in turn did the Yonge. In 1960 the boxes and the old proscenium arch were ripped out in anticipation of Cinerama, though in fact no film shot in Cinerama was ever exhibited there. By 1978, when it was renamed the Elgin, the theatre had long since become accustomed to showing films with the word *Vixens* in the title.

No one connected with either project is ever likely to admit the link, but some of the impetus needed to undertake restoration of the Elgin and Winter Garden, as the total complex is now called, must have come

Vaudeville may be passé but new forms of popular theatre, such as musicals, have found a large and enthusiastic following

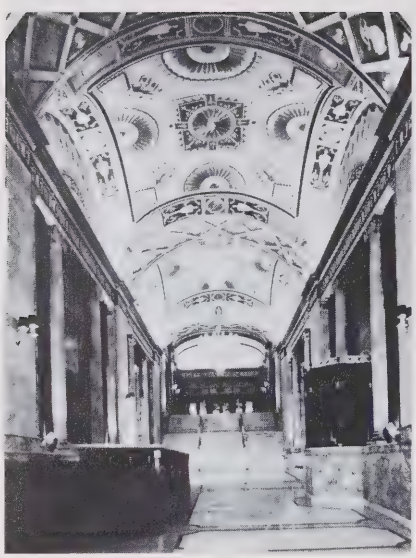
from the Pantages up the street. By 1970 the Imperial, one of the few grand old movie palaces left in Canada, had been broken up into the usual multi-screen complex; *The Godfather* was the last film shown in the old space before it was partitioned off to make the Imperial Six, which came under the control of Cineplex Odeon, the corporation headed by Garth Drabinsky. In 1988 the company began spending $18 million to reconvert the building to the 3600-seat legitimate theatre it once was, complete with painted plaster figurines, brass railings and enormous chandeliers, with entrances on both Victoria and Yonge, as of old, as described in Constance Olsheski's book *The Pantages: Rebirth of a Landmark* (Key Porter Books). Not that vaudeville itself would ever come back. As with the trend in theatre restoration sweeping Canada, from Le Monument National in Montreal to the Capitol in Nelson, B.C., the emphasis must now be on the middle class and on middlebrow fare. The Pantages re-opened in September 1989 with a production of *The Phantom of the Opera.* Subsequently, Drabinsky was unsuccessful in his attempt to buy out the other investors in Cineplex Odeon and so left the chairmanship of the company, but for $75 million he purchased for himself the company's live theatre division, whose centrepiece is the Pantages.

Meanwhile, the long process of resuscitating the Elgin and Winter Garden was well under way. Not that there had been much question that they would not be saved, for their importance had already been recognized.

The Elgin was still struggling along showing movies when at the end of 1981 the Ontario Heritage Foundation acquired the two theatres, which were given status as national historic sites the following year. It would seem that ever since its closure in 1928, a few people had been permitted to enter the lost world of the Winter Garden. Some of the stained-glass lanterns and other fixtures and fittings had been taken away as souvenirs, and at some point the seats were ripped out. "There was even talk in the mid-1940s of reopening the Winter Garden, decorating it in the Chinese modern style," says Kevin Harper, a researcher on the project, with a shudder in his voice. "But of course it stayed closed. The fact that the windows were painted black kept out the light and helped to preserve everything that was left." When work began, the foundation discovered 120 pieces of old painted backdrops from vaudeville days. They constitute the largest collection of original flats in existence, and plans were made to exhibit them on a rotating basis elsewhere in the new complex.

The first priority was to restore the Elgin to a condition in which it might once again accommodate live performances, thus establishing its viability and giving the public, whose support would be crucial to the master plan, an opportunity to admire the place and muse on its possibilities. The retrofit began in October 1984, and years of damage and neglect were reversed. To prove that the theatre was special rather than merely usable, the colonnaded lobby was restored as well. By actual count, twenty-seven layers of paint were removed from the pillars before the old marble was revealed. By March 1985, right on schedule, a production of *Cats* opened (using a number of old backdrops from the late 1920s). It ran for two years as anticipated; then the house went dark again so the rest of the work could get underway.

Now that the job is done, and now that Hilary Russell has documented the entire process in a book entitled *Double Take: The Story of the Elgin and Winter Garden Theatres* (Dundurn Press), it is easier to see how the restoration required the close co-operation of historical researchers as well as of architects and craftspeople. The team was given an initial boost by the fact that Thomas Lamb's architectural drawings were



CINEPLEX ODEON

This view of the new Pantages Theatre looks east towards the lobby showing the restored scagliola panelling, the new chandeliers, and the newly rebuilt original ticket booth with stained-glass roof.

As can be seen in this view of the completed ceiling, during the restoration of the Pantages Theatre a great deal of attention was paid to the recreation of the building's very complex decorative details.

rumoured to be stored in a disused room above one of the Broadway theatres with which he had been associated. The usual repositories of such information, such as the library of the Theatre Historical Society in New York, proved useful as well. "Fortunately, a trade magazine called *Construction* published an article about the theatre back in 1913, with photos taken on opening night," says Kevin Harper. But such resources only underscored what painstaking and expensive work would be necessary to make everything sympathetic to the original design and period.

In Toronto, newspapers have begun to use the phrase "theatre district." A concept thought long dead has been brought back to life

Sometimes exactness was attainable, as when the project team used a small swatch of the original Elgin carpeting as a basis for commissioning new floor-covering, the way scientists might make a clone from the smallest bit of genetic material. In other cases, such verisimilitude wasn't possible. "Originally there was a mural called *John Graves Simcoe Greeting the Indians* up there," says Harper, pointing up above the Elgin's stage. "It was destroyed in the 1928 fire, and we know about it only from written descriptions. But we think it must have been like a mural of George Washington used in one of the theatres Lamb built in New York." In still other instances, history could only be approximated. The seats in the Winter Garden are close to the original ones, for example. They came from the Biograph cinema in Chicago, where John Dillinger spent his last hours before he was killed by the FBI in 1934.

Such concerns, however, had to go hand-in-hand with the problems of how to make the building more suitable to contemporary needs and to make what already existed more accessible and practical. One essential part of the plan drawn up by the project architect, Mandel Sprachman, was to build a lounge below street level, under the orchestra pit, which meant first constructing a new cellar. This involved digging a tunnel large enough to accommodate dump trucks and bulldozers. Also, there needed to be better access to the Winter Garden than the Grand Staircase and the three quaint elevator cages. So a new five-level section was put up within the existing space; the strata would be linked to one another by escalators and connected to the lobby by a kind of bridge. These new additions, where patrons can lounge during intermissions, were deliberately kept as spare and modern as possible, so as to emphasize the ornate style of the other part of the building.

The behind-the-scenes portion of the theatres was added to as well. In the original design, the Elgin and the Winter Garden shared dressing rooms, which were scattered up and down the back staircase linking the two theatres; they were too few, too small, and too far apart; during *Cats*, for example, there were three cats to a space. So an eighth storey was built, providing not only more dressing space but a rehearsal hall and a carpentry shop. In all, the new public and backstage areas total 6045 square metres.

Initially it was hoped that all this could be accomplished for $15 million. In fact, the final revised budget was $29 million, a significant percentage of which was spent on necessary improvements not visible to the eye, such as a new electrical system and a new roof. The Ontario government put up $6 million and the federal government $5 million, and as soon as construction began there was a call for tenders from private firms wishing to operate the finished complex. The winning submission was from Marlene Smith and Ernie Rubenstein, the theatrical producers who had mounted the run of *Cats*. Later, an elaborate scheme for personal and corporate sponsorship was put in place, though individuals were not overlooked. People had the chance to "purchase" seats in their own or someone else's name, rather as old families once had pews "belonging" to them in their local churches. The two performances with which the complex reopened last December—*The Wizard of Oz* in the Elgin and *Side by Side by Sondheim* in the Winter Garden—were themselves fund-raising events.

As for the future, the theatres should be self-sustaining. "The operators are to pay a $1 million licence fee plus a percentage of the profits," Jerry Colman, the project's marketing manager, explains. "The operators get no real subsidy from the government. They're on their own." Already the Toronto newspapers have begun using the phrase "theatre district," thus proving that a concept thought long dead has indeed been brought back to life.

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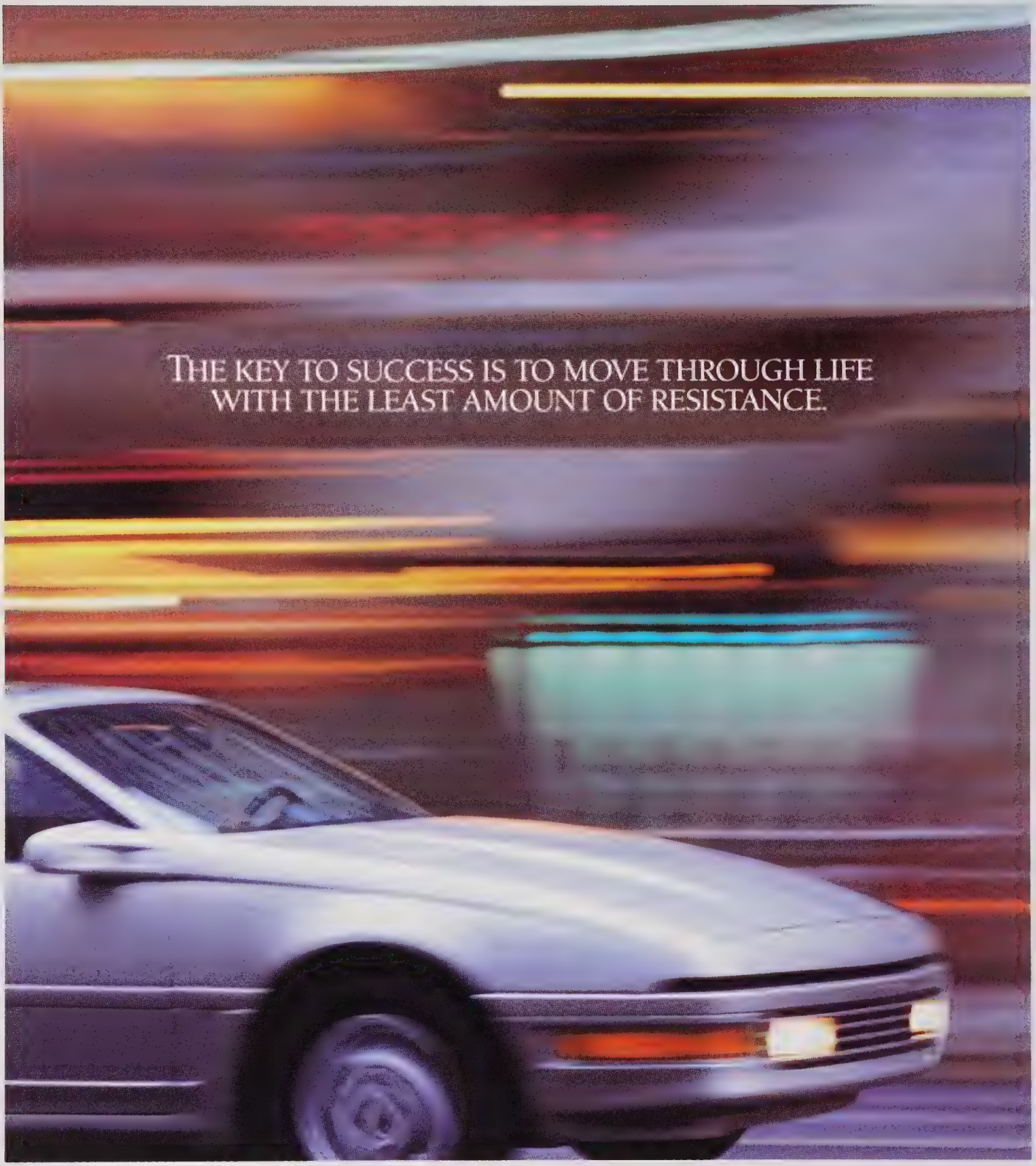

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SCOTLAND'S GARDEN QUARTET

The Royal Botanic Garden, Edinburgh, is really four gardens, renowned as much for their research facilities as for their beauty

JOHN MCNEILL

EXPERTS ON ALPINE PLANTS SAY THAT THERE ARE TWO GREAT ROCK gardens in the world and debate which is the finer: the one in Munich, Germany, or the one that is an integral part of the beauty of the Royal Botanic Garden, Edinburgh. The Edinburgh garden is more than just the setting for a fine rock garden flanked by beds of heaths in magnificent colour late in the year and by a woodland glade with peat walls developed for acid-loving plants of woodland and bog; it is more than just an extensive leafy arboretum rising to a gentle eminence providing fine views of a fine city skyscape; it is more even than the setting for what is probably the world's richest collection of *Rhododendron* species in magnificent colour in the spring and early summer.

The characteristic feature of the Royal Botanic Garden, and one that it shares with other great botanic gardens around the world, is to be discerned in its origins and in its history. It was founded in 1670 as the result of the efforts of two Edinburgh physicians, Dr. Andrew Balfour and Dr. Robert Sibbald. Both had undertaken part of their training on the Continent and were appalled at the state of medicine in Edinburgh, and, in particular, the lack of a pharmacopoeia of standard drugs. The need to grow medicinal herbs was evident, and Sibbald and Balfour established a physic garden at a site not very far from the Palace of Holyroodhouse at the foot of the Royal Mile, the series of streets running from Edinburgh Castle to the palace along the ridge of the Old Town of Edinburgh. The garden proved such a success that a

PHOTOGRAPHY COURTESY ROYAL BOTANIC GARDEN, EDINBURGH

John McNeill is associate director curatorial of the Royal Ontario Museum. Before moving to Toronto in 1989, he was Regius Keeper of the Royal Botanic Garden, Edinburgh.

larger area was soon needed, and in 1675 a site was obtained very near to the present location of Waverley, the main railway station.

Robert Sibbald was commemorated by the great Swedish botanist Linnaeus, who gave the name *Sibbaldia* to a small genus of rosaceous plants, closely related to the strawberry. As Sibbald and Balfour were both busy doctors, they obtained the services of a botanist, James Sutherland, to direct the garden. He soon became responsible for the teaching of botany at the University of Edinburgh, where he also established a college garden. In 1695 a chair of botany was created for him. In the same year he was given charge of that portion of the Royal Garden at Holyrood known as the King's Garden, thus becoming the first Regius Keeper, the title given by royal warrant to the chief executive officer of the Royal Botanic Garden, Edinburgh, to this day.

Sir Robert Sibbald (1641-1722), an Edinburgh physician and one of the founders (with Sir Andrew Balfour) of the Royal Botanic Garden, Edinburgh.

The origins of the Royal Botanic Garden, Edinburgh, were thus clearly rooted in economic necessity: the need to provide *materia medica* for rapidly developing medical science. The history of the garden over the next two centuries reflects the unfolding of this medical theme, particularly in the close links with teaching in the university's Faculty of Medicine. During the politically turbulent years following the union of Scotland and England in 1707 and the Jacobite rebellion of 1715, the Town (or Physic) and College gardens were under separate direction from the Royal Garden and suffered neglect. From the 1730s, however, a succession of far-sighted Regius Keepers—all of whom, incidentally, were also medical practitioners—recognized the importance of knowing the properties of all plants. Hence as wide a range as possible was grown rather than just those of known pharmacological value. This broadly based approach to botany and the combination of the three gardens under John Hope, who was appointed Regius Keeper in 1761, led to moves to new and larger sites.

The mid-18th century saw the first move of the botanic garden from what had become a cramped and atmospherically polluted site to a new location on Leith Walk, the road stretching from the then inland city of Edinburgh to its port at Leith on the Firth of Forth. The garden soon outgrew that site as well and moved to its present location between 1821 and 1823. The two-year operation included the removal of mature trees, which were borne by horse and cart across the city. The new site lies in the area of Edinburgh known as Inverleith.

Edinburgh in the 18th century, showing Trinity Hospital, where James Sutherland, the first Regius Keeper of the Royal Botanic Garden, obtained in 1675 ground for the garden's second site. Today the garden is located adjacent to Waverley, the main railway station.

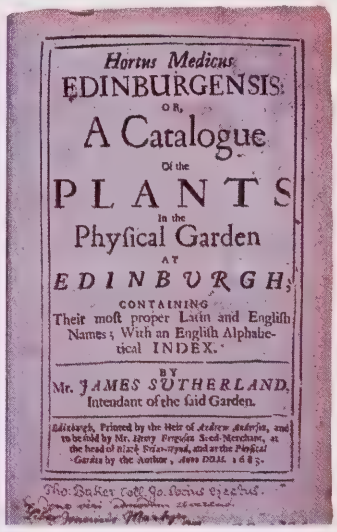
The Regius Keeper at the time of the move to Inverleith was a Dr. Robert Graham, but the person primarily responsible for the move and for designing the machine that allowed 6-metre hawthorns and 12-metre alders and birches to be transplanted successfully was William McNab, who held the post now called curator from 1810 until his death in 1848. The development of the Inverleith site and the establishment of the foundations of the present garden rested with their successors, Dr. John Hutton Balfour (Regius Keeper from 1845 to 1879) and William McNab's son, James McNab, who succeeded his father as curator in 1849 and who continued in that post until his death in 1878.

While Hutton Balfour established a solid reputation for

botanical teaching in the Faculty of Medicine, McNab concentrated on the garden. With the fortunate acquisition of the garden of the Royal Caledonian Horticultural Society he obtained much-needed room for expansion. New space made possible the creation of the rock garden for which the Royal Botanic Garden is now rightly famous. McNab's original rock garden looks incredibly formal today, but it doubtless reflected Victorian taste and represented a horticultural innovation that McNab's successors were able to nurture to its present grandeur.

The origins of the Royal Botanic Garden, Edinburgh, were rooted in economic necessity: the need to provide medical materials for rapidly developing medical science. The medical theme continued well into the 20th century, as close links were maintained with the Faculty of Medicine of the University of Edinburgh

Certainly the garden was a popular feature in Edinburgh in Victorian days. One of the more interesting vignettes of that period is the controversy over Sunday opening. In 1862 a petition signed by 14,000 working men was submitted to the Lords of Her Majesty's Treasury "praying that the Royal Botanic Garden might be open to the public on Sunday afternoons after the usual hours of public worship." This had long been the practice of the Royal Botanic Gardens, Kew, and at what is now the National Botanic Garden in Dublin. Almost at once the Lordships of the Treasury were confronted with a counter-petition from a society called the Sabbath Alliance, which had gathered the signatures of 48,522 men, women, and boys. This was challenged by a later petition to have the garden opened, signed by 36,897 men. The matter went to the House of Commons and in March 1863, by a vote of 123 to 107, it was resolved to keep the garden closed on Sundays. Finally in 1889 Sunday opening was permitted despite the opposition of the Sabbath Alliance. In the years following, and indeed well into the 20th century, attendance at the garden on Sunday often exceeded that for the rest of the week.


Hortus Medicus
EDINBURGENSIS:
OR,
A Catalogue
Of the
PLANTS
In the
Physical Garden
AT
EDINBURGH;
CONTAINING
Their most proper Latin and English Names; With an English Alphabetical INDEX.
BY
Mr. JAMES SUTHERLAND,
Intendant of the said Garden.

Title page of *Hortus Medicus Edinburgensis* or a *Catalogue of the Plants in the Physical Garden at Edinburgh* by James Sutherland, the garden's first Regius Keeper. Appearing in 1683, the 446-page book represents the first scientific research publication of the Royal Botanic Garden.

With the appointment in 1888 of Professor Isaac Bayley Balfour, the son of John Hutton Balfour, to the positions of Regius Keeper of the garden and Regius Professor of Botany in the University of Edinburgh, work began to make the garden an internationally respected centre for scientific research on the kinds and diversity of plants. Bayley Balfour, who had moved from the Sherardian Chair of Botany in the University of Oxford, was not only an outstanding botanist, he was also a skilful administrator. During his period as Regius Professor and Regius Keeper, glasshouses were restored, the rock garden was reconstructed, modern laboratories were built, and a scientific journal was initiated.

The decisive action of Bayley Balfour reflected, in part, his realization that the times permitted the exploration of the interior of China, a part of the world hitherto almost unknown to scientific botany. Political situations had changed and transportation had improved. From the evidence of the few introductions up to that time, he suspected the area would be rich in novelties that would be of major importance to European horticulture.

Events proved that Bayley Balfour's judgement in encouraging botanical exploration in China was fully justified. He wisely selected a young man, George Forrest, to lead successive expeditions from Edinburgh principally to southwestern China, notably the Province of Yunnan. Forrest's work and that of other collectors, such as E. H. Wilson and later Frank Kingdon-Ward and Joseph Rock, changed the face of horticulture in Britain, with old standbys such as privet, holly, and yew being replaced by rhododendrons, camellias, magnolias, primulas, and species of *Meconopsis*. This, coupled with Bayley Balfour's own research on the explor-

ers' many discoveries, transformed Edinburgh into the world's leading centre for research on the Sino-Himalayan flora, a tradition that was maintained after Bayley Balfour's death in 1922.

The arrival after World War II of Peter H. Davis as a mature student of the University proved equally important in developing the scientific activities of the Royal Botanic Garden, Edinburgh. Already a seasoned collector from his experiences as an intelligence officer in the Middle East during the war, he made his lifetime goal the completion of a flora of Turkey, that is, an account of all the plants of that botanically rich and then still poorly known country. Davis's extensive collecting in the 1950s and 1960s, and the work of other expeditions from Edinburgh to southwest Asia, led to the establishment of expertise in this part of Asia quite rivalling that which had been achieved earlier in eastern Asia. The Royal Botanic Garden, Edinburgh, now counts the entire continent of Asia, tropical as well as temperate, as an area of geographic specialization.

Professor Sir Isaac Bailey Balfour (1853-1922), Regius Keeper and Professor of Botany (1888-1922), at his lecture table.

Plant collecting consists not only of bringing back seeds and cuttings for horticultural use, but also involves the pressing and drying of portions of plants, so that these can be preserved permanently as a record of the diversity of the world's flora. These herbarium specimens are the most effective way of providing comparative samples of all the world's vegetation in one place and at one time. It is through their use that botanists can understand the evolutionary relationships of the plants with which they deal and can utilize this knowledge for practical purposes. The old exhibition hall of the Royal Caledonian Horticultural Society served as the herbarium for one hundred years. The new herbarium, opened in 1964, is an attractive architectural, as well as scientific, feature of the garden.

Almost as important as the herbarium specimens upon which the research is based is the provision of good library facilities from which the research findings of previous botanists can be evaluated. The botanical library at the Royal Botanic Garden, Edinburgh, was largely initiated by Bayley Balfour and further developed over the period since the Second World War. It is now one of the world's finest botanical libraries, worthily complementing the scientific research of the institution.

There are many other attractive features of the garden in Edinburgh. Its expanse of over 25 hectares allows the visitor to get a good impression of the garden in a first visit while leaving many interesting features for more detailed exploration on subsequent visits. The modern plant houses that are adjacent to the herbarium have a cantilevered structure, so that the interior permits desert vistas and tropical forests to be viewed undisturbed by pillars or other supports. A popular feature of the tropical houses is the aquatic house in which a giant water lily *Victoria amazonica, V. cruziana*, or a hybrid between the two species, is grown each year. The water lily is strong enough to support the weight of a child. The research plant houses permit propagation of rare and endangered tropical species, in some cases with a view to trying to re-establish them in natural habitats from which they have

A plate from one of the many rare books in the library of the Royal Botanic Garden, Edinburgh. The plant illustrated is the common fig, now known scientifically as *Ficus carica*; the Latin text below the plate includes two descriptive "polynomials," the only way to refer to plant species before the introduction in 1753 of binomial nomenclature by the Swedish botanist Linnaeus, as a by-product of his so-called sexual system. Professor John Hope, Regius Keeper from 1761 to 1786, was an enthusiastic proponent of Linnaeus's system, which permitted the assimilation of the vast diversity of hitherto unknown plants brought back from the new worlds being explored in the 17th and 18th centuries.

been lost. Visits to the Victorian Temperate Palm House and to Inverleith House, where temporary exhibitions are displayed, and the adjacent Terrace Cafe are also most worthwhile.

The Royal Botanic Garden, Edinburgh is no longer confined to Edinburgh but comprises four gardens in different parts of Scotland. The expansion of the Edinburgh garden to other areas of the country also stems from the initiative of Sir Isaac Bayley Balfour. Although the richness of the Sino-Himalayan flora included herbaceous genera such as *Primula*, *Gentiana*, and *Meconopsis*, many of whose species could be grown very well at Edinburgh, it also included many trees and shrubs in genera such as *Rhododendron*, *Camellia*, and *Magnolia*. While some of their species grow well in Edinburgh, the range of species was limited by winter frosts and, more importantly, lack of space. Bayley Balfour was involved in negotiations for a site for growing rhododendrons in the west of Scotland, which has milder and wetter winters. The work he began culminated in the acquisition in 1928, six years after his death, of what is now the Younger Botanic Garden at Benmore, north of Dunoon, in the Cowall district of Argyll. This 50-hectare garden is in a magnificent location in the Eck Valley just north of the Holy Loch.

The Royal Botanic Garden, Edinburgh, has expanded to three additional sites in Scotland in order to better carry out its modern role as a leading international centre of botanical research. And for those with less scientific bents, all four gardens are also beautiful places to visit

One of the best displays of southern hemisphere plants in the northern hemisphere is to be found at the Logan Botanic Garden, established by the McDouall family and given by the Hambro Trustees to the Royal Botanic Garden, Edinburgh, in 1969. It is located in the southwest corner of Scotland, as near to Ireland as one can get. Frosts at Logan are rare. For this reason many plants that are not hardy elsewhere in Scotland or in most other places in Britain can be grown successfully. The most dramatic features are the cabbage palms (*Cordyline australis*) and tree ferns (*Dicksonia antarctica*), but the diversity of species that are grown at Logan makes it a plantsman's delight.

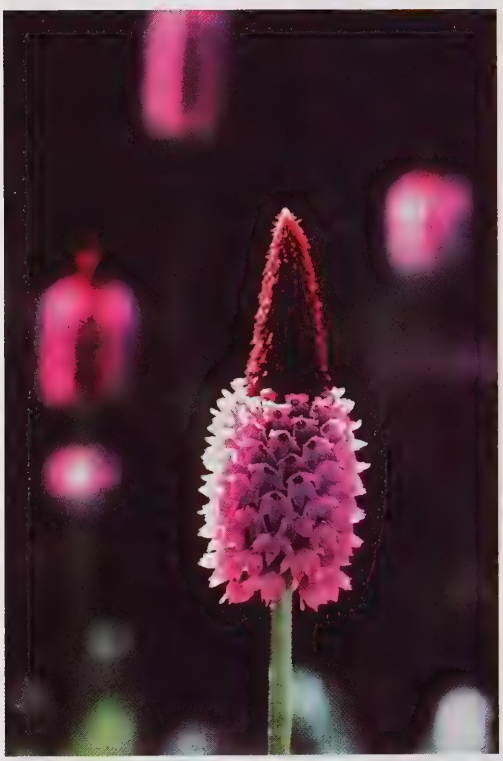
The research of the Royal Botanic Garden, Edinburgh, is not confined to flowering plants but also covers what are sometimes called the "lower plants," most notably the fungi (mushrooms and moulds). This painting by Beatrix Potter published with permission of the Perth Museum and Art Gallery where the original is housed, is of the cep, *Boletus edulis*. Best known as a writer of children's books, Beatrix Potter acquired an excellent knowledge of mushrooms and toadstools, and was frustrated by the discrimination of her day from becoming a professional mycologist. Her letters and some other papers are deposited in the library of the Royal Botanic Garden, Edinburgh.

Closer to Edinburgh lies Dawyck Botanic Garden, established as an arboretum by the Veitch and Naesmyth families in the 17th and 18th centuries. Specimens of Douglas fir (*Pseudotsuga menziesii*) grown from the original seed sent home by Douglas from the Columbia River area in 1834 can still be found in Scrape Glen. The largest tree is now more than 45 metres in height. The arboretum was acquired by the Royal Botanic Garden, Edinburgh, only in 1979, and its development as a botanic garden is still in progress. As part of a short day-trip from Edinburgh it is, however, well worth a visit. Although serving a comparable function to Benmore, in that it can contain a larger number of individuals of tree and shrub species than can be accommodated at Edinburgh, Dawyck differs in that it concentrates on species from areas with a more continental climate. The clear air and the less gradual transition from winter to summer that the higher altitude provides offer a better environment for such plants.

The four gardens that comprise the Royal Botanic Garden, Edinburgh, form an integrated pattern that provides the visitor to Scotland with a broad range of botanical and horticultural experiences. They also reflect the *raison d'être* of the institution by maintaining collections for scientific research that is vital for the understanding and conservation of plant diversity.

THE GARDEN AT EDINBURGH

Facing page: (*Above*): The Rock Garden as it was first established, very formally, by James McNab, curator, in the 19th century, and today (*below*), as it invites the visitor to meander through grassy meadows and gravel paths admiring cliff-loving plants and stream-side species. *Left:* The tropical aquatic house is where the floating leaves of the hybrid between the giant waterlilies *Victoria amazonica* and *V. cruziana*, commonly called the Longwood Hybrid are found. They are capable of supporting a child's weight. The flower buds come above water level and the flowers open for scarcely more than a day, although the plants produce a succession of flowers throughout the summer.



There is an overwhelming range of plants to see in the Royal Botanic Garden, Edinburgh. *From left to right: Primula vialii* is a species introduced from China by George Forrest. The annual border is a concession to the visitor who seeks bright colours rather than exotic species. *Magnolia kobus* is in full flower with several *Rhododendron* species growing by the peat walls, which are banks of peat that nurture plants that thrive in acid soils. *Top: Dendrobium cuthbertsonii* flowers in the orchid house.

DAWYCK BOTANIC GARDEN, PEEBLESHIRE

Left: Ferns and primulas decorate the banks of Scrape Burn, the stream that cuts a deep valley through the garden. *Right:* The beech walk, pictured here in winter, is one of the formal features that adds to the charm of this rich arboretum.

THE YOUNGER BOTANIC GARDEN, BENMORE, ARGYLLSHIRE

Centre: This is a general view of the hillside above Benmore House and the formal garden with its banks of Hobbie hybrid rhododendrons. *Top:* The yellow-flowered *Rhododendron sidereum* contrasts with (*right*) the more subtle *Sorbus pteridophylla*, a white-fruited Chinese relative of the rowan or mountain-ash (*S. aucuparia*).

THE LOGAN BOTANIC GARDEN, NEAR STRANRAER

Left: Logan is known for its tree ferns such as *Dicksonia antarctica*. *Right:* Cabbage palms (*Cordyline sp.*) and *Agapanthus* grow in front of the ruins of the old Castle of Balzieland, the original keep of the McDoualls of Logan, whose ownership of the estate dates to the 12th century and whose descendants established the garden early in this century.

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The Monsters of Pit Eleven

Pit Eleven fossils provide the best picture we have of life on the land and in the sea 300 million years ago

Desmond Collins

Conical hills rise above the flat plain around Braidwood, Illinois, about an hour's drive southwest of Chicago. They are the spoil heaps from shallow shaft coal mines, now abandoned. For fossil collectors, they are also reminders of the monsters of Pit Eleven.

Pit Eleven sounds like a camp for lost souls in Hades, but it was actually a coal pit in the Illinois farmland where giant machines crept slowly over the ground, chewing it up, clawing out the coal, and spitting out the overlying shale and dirt in long heaps. The soft shale soon weathered to clay, the rain washed it down, and round red rocks, called concretions, were exposed on the spoil heaps like raisins in a pudding. Then the concretions split open and the monsters appeared. They are elongate, up to 30 centimetres long, with faint segmentation, a large triangular tail, a transverse crossbar towards the front with a ball—perhaps an eye—at each end, and right at the front a long trunk with a toothed claw.

PHOTOGRAPHY BY DESMOND COLLINS

The Peabody Coal Company's mechanical monster, the bucket wheel known as Big Dipper, is seen working in Pit Eleven in 1972.

The first ones were found by Francis Tully of Joliet in 1955. He took a couple to the Field Museum in Chicago, and showed them to Gene Richardson, curator of fossil invertebrates. Richardson had never seen anything like them. No one he showed them to knew what they were; they remain unclassified to this day. Richardson called the species *Tullimonstrum gregarium*; it is more popularly known as the Tully monster. The Field Museum proceeded to acquire hundreds of specimens, mostly from Pit Eleven.

The site yielded many other fossils, primarily of sea animals, and so it became a mecca for fossil collectors. By law, the spoil heaps should have been levelled and covered with seeded sod, but that would have covered the concretions. Collectors petitioned the state authorities, who ruled that so long as the collectors had access to collect the fossils, the Peabody Coal Company did not have to rehabilitate the pit.

Desmond Collins is curator in the Department of Invertebrate Palaeontology, Royal Ontario Museum.

The coal was exhausted by 1972. From the air Pit Eleven looked like the habitat of an enormous worm that had left rows of castings over 13 square kilometres. On the ground, it appeared desolate. With a surface dotted with bright red rocks, Pit Eleven resembled a space-probe photograph of the surface of Mars. Commonwealth Edison bought the pit in 1972 and converted it into a giant cooling pond for two nuclear reactors. No one could claim that radiation from the power plant had destroyed the vegetation because the area already looked as though it had suffered from a nuclear meltdown. Moreover, measurable radiation from radioactive elements concentrated in the organic components was already present in the spoil heaps.

Since 1972 the best fossil collection from Pit Eleven has been assembled by Karlene and Steve Ramsdell of Chicago. The ROM purchased their collection in two stages, in 1984 and in 1988. I joined the Ramsdells in April 1989 on one of their visits to Pit Eleven. I wanted to see where their collections had come from and to collect some of the fossil concretions myself. We began at the southern end in what is now a sportsmen's club. Here, unfortunately, many of the better spoil heaps for collecting are now overgrown. Still, we picked up some peculiar fossils called blobs by all the collectors and a couple of worms in concretions already split open. Then we drove north to the Braidwood Nuclear Power Station and back around the southern end of the cooling lake. Our modern-day version of a happy Charon, Steve Ramsdell, took us across to the islands where we would seek the monsters exhumed from their 300-million-year-old burial.

Surrounded by fresh water, and with naturally seeded shrubs and grasses, the islands look like wilderness in the Illinois countryside. Indeed, there is a state proposal to include the cooling lake in a large wildlife refuge. The Ramsdells and I scoured the hills and walked the islands' shorelines looking for concretions exposed or washed out during the past winter. Looming in the background were the twin towers of the nuclear reactors. Over a couple of hours two buckets of concretions, mostly unsplit, were collected. The best specimen I collected, already split open, was an echiurid worm, *Coprinoscolex*. This is the only place in the world where fossil echiurids are known to occur.

PHOTOGRAPHY BY BRIAN BOYLE, ROYAL ONTARIO MUSEUM

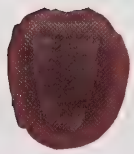
Popularly known as the Tully monster, fossil specimens of *Tullimonstrum gregarium* are among the natural phenomena found in Pit Eleven.

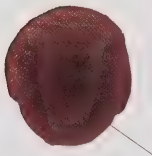
After this day of collecting I began to appreciate the tremendous effort required to assemble the whole Ramsdell collection. The collection comprises thousands of concretions and weighs more than nine tonnes. On average one in two concretions found has some organic remains. Of these blobs make up 70 per cent and plants another 20 per cent. The remaining 10 per cent have the animal fossils we sought.

The process of splitting concretions to expose fossils takes considerable time. It begins by placing the concretions in buck-

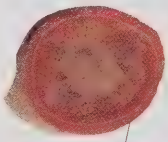
A Reconstruction of Pit Eleven

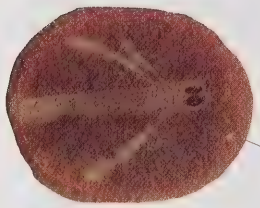
In this reconstruction of Pit Eleven, Marianne Collins, an artist at the Royal Ontario Museum, has brought to life the fossil remains shown with the drawing.



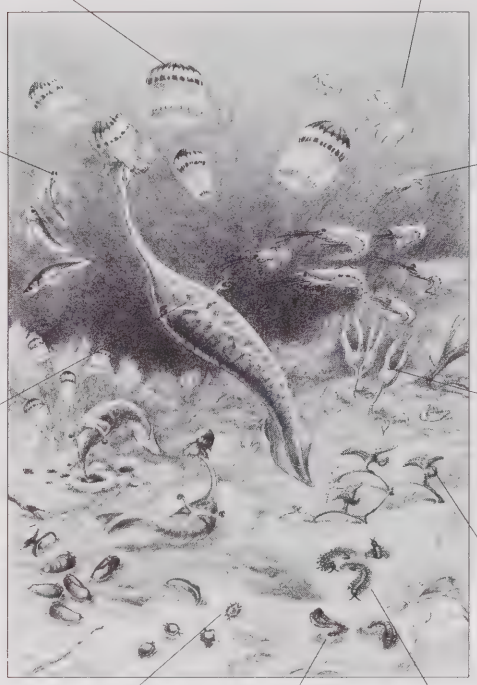


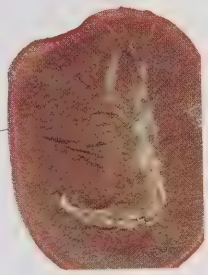
Blobs (left) may have been jellyfishes, albeit odd ones because they lacked tentacles. *Octomedusa* (right), with eight tentacles, were by comparison conventional jellyfishes.





Esconichthys, a larval-form fish commonly known as a blade, represents the species of fish most often found in Pit Eleven.



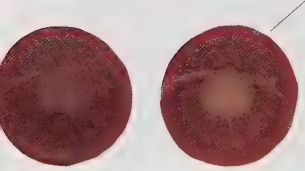


Fossil shrimps, like the *Belotelson magister*, are plentiful in Pit Eleven. Whether the shrimps were as plentiful in life is questionable. Some of the fossils may have been moults.

A *Tullimonstrum gregarium*, popularly known as a Tully monster, is pictured grabbing what collectors refer to as a blob.

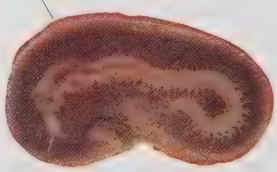
Escumasia, the Y animal, represents a previously unknown animal group.

The H animals, formally called *Etacystis*, may have been the extensions of siphonophores, animals whose bodies lay semi-burrowed in the muddy bottoms of bodies of water.



The peculiar-looking arthropod *Cyclus* is shown as it probably lived on or above the sea floor.

There are many types of polychaetes (bristleworms) found in Pit Eleven, such as *Didontogaster cordyline* (left) and *Esconites zelus* (right), which were probably yanked from their burrows by hungry Tully monsters.



PHOTOGRAPHY BY BRIAN BOYLE, ROYAL ONTARIO MUSEUM

What was life like 300 million years ago for the animals known to us as Pit Eleven fossils?

ets filled with water, where the water then seeps into the rock through tiny cracks in the stone. During winter the water freezes and expands, widening the cracks. After a thaw, more water enters the cracks and the process is repeated. It takes an average of about forty freeze-thaw cycles over two winters before the concretions finally split.

After the Ramsdell collection arrived at the ROM, Janet Waddington, a curatorial assistant in the Department of Invertebrate Palaeontology, supervised the washing and sorting of the split concretions. More than 250 buckets of unsplit concretions in water were put on the Museum's roof in the fall of 1989. The department is eagerly waiting to see what creatures may be found once the concretions split.

WHAT WAS LIFE LIKE FOR THE PLANTS AND animals known to us as Pit Eleven fossils? In the Carboniferous Period, 300 million years ago, the area of northeastern Illinois that includes Pit Eleven was a swampy delta, much like today's Mississippi delta in Louisiana. The land was forested, and inhabited by terrestrial invertebrates—spiders, centipedes, and primitive insects—and the first land vertebrates, the amphibians. The sea was muddy from river sediment deposited in the delta. This environment excluded animals from the open sea, such as corals, ammonoids, and starfishes. Instead, it teemed with great varieties of shrimps, worms, clams, jellyfishes, and fishes, along with the Tully monsters and many, many blobs.

The muddy, deltaic environment probably caused the preservation of the fossils in concretions. Dead animals and plants were quickly buried by the mud and so were not scavenged. Early decomposition of the remains changed the pH of the enclosing mud, precipitating layers of iron carbonate around them. This sealed in the remains and prevented further decay. In effect, the initial decomposition of the buried remains caused them to be enclosed in a stony sarcophagus.

As is the case in the sea around the Mississippi delta today, different populations of animals are found in different parts of Pit Eleven. In the part of the pit where the Tully monsters are found, many blobs occur as well. Because the tiny teeth in their claws could tear soft tissue only, Tully monsters would not have been able to successfully attack shrimps or other armoured animals. One can presume that blobs were a major part of the monsters' diet.

Blobs earned their name for their odd appearance, which makes classification very difficult. The best ones, blobs with character, as they are called by the collectors, are composed of a smooth bell shape on top and a large smooth skirt below, sometimes with a fringe. Blobs can measure up to 15 centimetres in length, but most are much smaller. They could have been jellyfish, but if this were true, they were peculiar ones, because they appear to have lacked tentacles. The other jellyfishes present in Pit Eleven, such as *Octomedusa* with its eight tentacles, are conventional by comparison.

Alternatively, the Tully monster may have eaten bristleworms (polychaetes). There are many such worms preserved in Pit Eleven concretions. Indeed, this is probably the best site in the world for fossil polychaetes, both in number and variety (17 species). The two species that occur most often with the Tully monsters are *Esconites* and *Didontogaster.* The Tully monster trunk and claw would appear to have been ideal for groping into burrows and yanking out the worms, and the wideset eyes on the bar projecting beyond the body would have allowed the monster to look below to see where to put its claw.

Two other very strange fossils from the region of Pit Eleven inhabited by the Tully monsters are known as the H and Y animals because of their shapes. The H animal, formally called *Etacystis,* may have been part of a siphonophore. Siphonophores are creatures that live semi-burrowed in the muddy bottom of a body of water and have extensions that they send up into the water. The H animals may have been siphonophore extensions. The Y animal, *Escumasia,* appears to have been as nightmarish as the Tully monster, and may also represent a previously unknown animal group.

After blobs, the animal fossils most commonly found throughout Pit Eleven are shrimps, especially the genus *Belotelson.* It is possible that the shrimps were not as plentiful as the concretions indicate because many of the fossils may have been moults, the external armour shed as the shrimp grew in size.

PHOTOGRAPHY COURTESY OF DESMOND COLLINS

An aerial view of Pit Eleven in 1971, before it was converted to a nuclear cooling pond. From the air it looked like the habitat of a giant worm; from the ground it was simply desolate. It remains a mecca for fossil collectors.

Occurring with the Tully monsters in Pit Eleven are a peculiar arthropod, *Cyclus*, that probably lived on or above the sea bottom, and clams and pectens that lived on the bottom. *Esconichthys* are the most common fishes. Popularly known as blades, they are larval forms with prominent eyes, a tadpolelike tail, and lateral branched "feelers."

But the world of the Tully monster is only one part of Pit Eleven. Cucumber Hill, for example, is the spoil heap where the sea-cucumber, *Achistrum*, is frequently found. The Pit Eleven sea was also populated by more wormlike animals such as chaetognaths (arrow worms), priapulids, and echiurids. There were some notable crustaceans—shrimps, lobsters, an isopod, and also one of the earliest known goose-barnacles, *Praelepas*. The onychophoran, *Helenodora*, a primitive early arthropod, is one of only three onychophoran genera known in the fossil record. Its rarity makes it a special find.

Except for the blades, fishes are rare throughout Pit Eleven. Yet the hundreds of thousands of concretions collected contain many different kinds of fishes. They include jawless fishes like *Mayomyzon*, the first fossil sea-lamprey ever found. Primitive sharks, ratfishes, lungfishes, and coelocanths are also present. The most common coelocanth, *Rhabdoderma*, is sometimes preserved with its yolk-sac still attached. One of the most spectacular specimens is a paleoniscoid, *Elonichthys*, a type of extinct fish, which choked to death on an *Acanthodes*, another kind of extinct fish, which it had attempted to swallow. It is an instant of life and death preserved for us to see 300 million years later.

The Pit Eleven fossils are unique because of the very detailed image that they offer of life 300 million years ago. They are second in importance only to the much older Burgess Shale fauna in British Columbia for increasing our knowledge of the evolution of life. In recognition of the importance of the Pit Eleven fossils and because of its own unique charm, the Tully monster was recently named the official state fossil for Illinois. The ROM will have a major display of Pit Eleven fossils in the new gallery Evolution of Life Through Time.

PHOTOGRAPHY BY BRIAN BOYLE, ROYAL ONTARIO MUSEUM

The most common fossil coelocanth found in Pit Eleven is *Rhabdoderma robusto*, sometimes preserved with its yolk-sac still attached as in this specimen.

The Ramsdell collection of Pit Eleven fossils is a particularly fine one. The Royal Ontario Museum is most grateful to Karlene and Steve Ramsdell; Dr. Jarmila Kukalova-Peck of Carleton University, who informed the Museum of the 1984 Ramsdell collection; Dr. Charles Shabica and Steve Sroka of Northeastern Illinois University, Chicago, who helped arrange the purchase of the 1984 collection; David Walden and the Canadian Cultural Property Secretariat in Ottawa, who helped with a substantial federal grant; and the membership of the ROM for the donation of funds towards the purchase of the 1988 collection.

Now We Talk –You Listen–

Indian delegates at a conference in 1939 joined together to speak for themselves

Donald Smith

In 1939 Dr. Tom McIlwraith, an anthropologist at the University of Toronto and curator of the ethnological collections of the Royal Ontario Museum of Archaeology, and Professor Charles Loram of Yale University organized a two-week conference on the North American Indian hosted by the University of Toronto. Over 70 Canadian and American government officials, missionaries, and academics were invited to attend this important event, which was held at the Museum. More importantly 12 North American Indians were also invited. This was the

first conference ever held to discuss Indian welfare and the first Canadian scholarly conference to invite Indian delegates. In the words of the organizers the purpose was "to reveal the actual conditions today of the white man's Indian wards, and in a scientific, objective and sympathetic spirit, plan with them for their future." The conference concluded in a most unexpected way.

Donald Smith is a professor of history at the University of Calgary.

Fifty years ago, most Canadians rarely gave any thought to native issues because it was commonly believed that the Indians were a vanishing people. In fact, the famous Canadian anthropologist Diamond Jenness wrote in his book *The Indians of Canada* (1932): "It is not possible now to determine what will be the final influence of the aborigines on the generations of Canadian people still to come. Doubtless all the tribes will disappear. Some will endure only a few years longer, others, like the Eskimo, may last several centuries." Through intermarriage with non-natives, and cultural assimilation into the larger society, it was assumed that Indians would become extinct.

Perhaps it was most appropriate for the conference to be held in Toronto, one of Canada's most populated cities. Indians in the 1930s were a more distant and foreign people to the citizens of Toronto than to Canadians in other urban centres. Unlike Montreal, which had the large Iroquois reserve at Kahnawake (Caughnawaga), or Vancouver with its neighbouring Squamish and Musqueam reserves, or Calgary, with the Sarcee reservation on the city's southwestern border, Toronto had no neighbouring Indian reserve. Once the local Mississauga Indians had held reserve land along the Credit River just west of the city, but the pressure of white settlement had forced them to leave. In 1847 the Mississauga of the Credit had relocated westwards to the Grand River, next to the Six Nations (Iroquois) near Brantford. By the 1930s Toronto had so forgotten the Mississauga Indians that the Indian shown in the city's coat-of-arms was a war-bonneted Plains Indian. (The

PHOTOGRAPHY BY PRINGLE AND BOOTH (COURTESY OF KEN KIDD)

The North American Indian conference 1939

Eight of the twelve Indian delegates can be identified (highlighted in beige from left to right)
Joe Peltier
Peter Kelly
Maurice Sanderson
Earl Calfchild
Teddy Yellowfly
D'Arcy McNickle
Arthur C. Parker
Edith Brant Monture

error was only corrected in 1961 when the Indian was given the costume of an 18th-century Mississauga.)

Few Torontonians even knew the meaning of the Iroquois name for their city. The Mississauga had always been told by the Iroquois that "Toronto" meant "looming of trees" or trees growing out of the water. As late as the 1860s one could still look from Queen Street south to Ashbridge's Bay to see trees that appeared to grow from the water.

From 1936 to 1938 Grey Owl was the best-known North American

Other important delegates
(highlighted in blue from left to right)
Ken Kidd
Thomas McIlwraith, organizer of the conference

Indian to Torontonians. The famous writer and lecturer, who lived and worked at his cabin in Saskatchewan's Prince Albert National Park, made two important public appearances in the city. He came to Toronto in November 1936 to attend the first Toronto Book Fair. The tall, dark, hawk-faced man, clad in moccasins and buckskins, with a single eagle feather in his hair, had just returned from his triumphant lecture tour of Britain the previous spring. The British press had responded warmly. Shortly after his arrival the London *Times* wrote: "A picturesque figure in Indian dress, with the thoughtful face of a philosopher, Grey Owl comes as the friend of nature." The *Manchester Guardian* reported that Grey Owl spoke in a concerned, earnest way about the wilderness and talked "with the true nasal twang of the Canadian Indian." Just before Grey Owl left London, the *Sunday Express* commented: "There never came a Redder Red Indian to Britain."

The Toronto organizers estimated that 800 people would come to hear Grey Owl in the King Edward Hotel's Crystal Ballroom. Instead nearly 1700 crowded into the room, and another 500 were turned away. He was preceded by his reputation as a skilled writer and lecturer on the land, the animals, and the people of Canada's North.

Until 1939, so few people gave thought to native issues that no one questioned Grey Owl's identity. When Grey Owl's true past was uncovered Ken Kidd of the Museum remarked, "I did not suspect that he was not an Indian, but in those days I was not very familiar with the real thing."

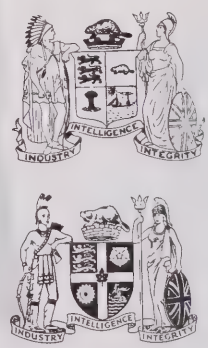
During his visit, Grey Owl discussed his racial background with Sir Charles G. D. Roberts, one of Canada's most distinguished men of letters. Sir Charles included the details in *The Canadian Who's Who, 1936-1937.* The entry reads, "born encampment, State of Sonora, Mexico; son of George, a native of Scotland, and Kathrine (Cochise) Belaney; a half-breed Apache Indian...adopted as blood-brother by Ojibway tribe, 1920...speaks Ojibway but has forgotten Apache."

Grey Owl also visited the Museum and met with its director Dr. Charles Trick Currelly. Ken Kidd, then a young assistant to Dr. McIlwraith, took Grey Owl through the exhibit of artifacts from Indians of the southwest United States. More than a half-century later, Kidd recalled, "I did not suspect that he was not an Indian, but in those days I was not very familiar with the real thing. The main impression he left with me was his saying that he had been born in Northern Mexico—I think in the State of Chihuahua—as his mother happened to be visiting there at the time. He was quite emphatic about this."

On 26 March 1938, only a year before Dr. McIlwraith's conference, Grey Owl came to Toronto again, addressing an audience of about 3000 in Massey Hall. This was to be his last visit to the city. Grey Owl had returned to Canada three months earlier from a second highly successful tour of the British Isles, in which he delivered nearly 150 lectures, including a royal command performance at Buckingham Palace. After his Toronto address, which was part of a seven-month tour of lectures on the importance of conservation in Britain, Canada, and the United States, Grey Owl returned totally exhausted to his cabin in Saskatchewan. He died in Prince Albert on 13 April 1938. Shortly after his death, the truth about his life was exposed.

By the time of the University of Toronto's conference in the fall of 1939, it was common knowledge that the most popular North American Indian was really one Archie Belaney, born and raised in Hastings, England, who had left home at the age of 17 to live in northern Canada. Belaney had so admired the Indians for their ability to adapt to their natural surroundings that in Canada he created a new identity for himself as an Indian. It was time that Torontonians and North Americans in general learned the facts about the Indian people.

From 4 to 16 September 1939, the conference delegates at the Museum heard from various non-native speakers about the cultures, reserve economics, health, and education of the Indians. Federal government officials pointed out that Canada's Indian population was no



Torontonians knew so little of the Mississauga Indians that once lived just west of the city that the Indian in Toronto's coat-of-arms was a war-bonneted Plains Indian. The error was corrected in 1961 when the Indian was costumed as an 18th-century Mississauga.

PHOTOGRAPHY FROM CITY OF TORONTO ARCHIVES SC266-41837

Outstanding personalities such as Sir Charles G. D. Roberts (right) may have paled in Grey Owl's presence, but not nearly as much as when they learned that Grey Owl was really an Englishman named Archie Belaney.

longer in decline: since the late 1930s the population had increased annually by one per cent.

The press paid little attention to the meetings because, unfortunately, the timing of the conference could not have been worse. Three days before sessions started at the Museum, Germany invaded Poland, and two days later Britain declared war on Germany. Throughout the first two weeks of September the press focused on the rapid German advance through western Poland. Midway through the conference, on 10 September, Canada declared war on Germany, and the day after the conference ended the Soviet Union invaded eastern Poland. The general public and press were too preoccupied to hear about the poor health conditions, unemployment, and the residential school system experienced by Indians.

On the last day of the conference delegates met to pass resolutions urging greater attention to "the psychological, social, and economic maladjustments of the Indian populations of the United States and Canada." A committee was established to oversee the publication of the conference's papers and the dissemination of information on North American Indians. And then a very dramatic defection took place. The Indian delegates broke from the main group and met separately to pass their own resolutions.

The Indian delegates resolved to have their own meetings. They did not need Grey Owls, government officials, missionaries, or white sympathizers to speak for them

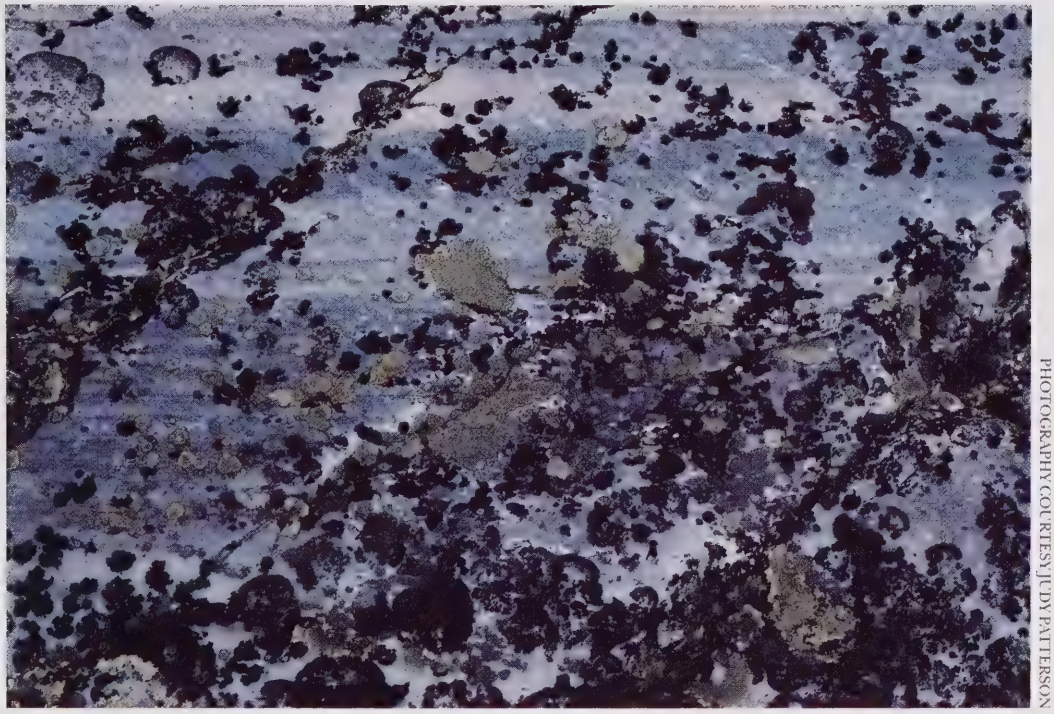
Members of the Indian delegation from the United States included Arthur C. Parker, an Iroquois anthropologist; D'Arcy McNickle, a distinguished academic; Louis Bruce, an Iroquois civil servant in New York State; David Owl, a Cherokee Christian missionary; and Ruth Muskrat Bronson, a Cherokee guidance officer with the Office of Indian Affairs in Washington. The delegates from Canada were Peter Kelly, a Haida United Church minister and an influential Indian leader in British Columbia; Teddy Yellowfly, the manager of the Blackfoot's coal mine in Alberta; Earl Calfchild, an interpreter from the Blackfoot band in Alberta; Çanon Maurice Sanderson, an ordained Anglican minister from Ontario; Joe Peltier, a respected Indian leader from Manitoulin Island; Norman Lickers of the Six Nations Reserve near Brantford, the first Indian lawyer in Ontario; and Edith Brant Monture, the great-great-granddaughter of Joseph Brant, the famous Iroquois chief.

While appreciative of their invitation to the conference, the Indians resolved to have their own meetings. They did not need government officials, missionaries, white sympathizers, or Grey Owls to speak for them. As part of their resolution they stated: "We hereby go on record as hoping that the need for an All-Indian Conference on Indian Welfare will be felt by Indian tribes, the delegates to such a conference to be limited to *bona fide* Indian leaders actually living among the Indian people of the reservations and reserves, and further, that such conference remain free of political, anthropological, missionary, administrative, or other domination."

Canadians did not hear the Indian voice in September 1939, drowned out as it was by the outbreak of the Second World War, but they did hear it after the war. The general acknowledgement of the strong contribution to the war effort made by Canada's native peoples and the injustice of their second-class status contributed to a growing public interest in native issues throughout the country.

Canada's native population continues to grow. Metropolitan Toronto now has a native population numbering in the tens of thousands. In the new multicultural Canada, native peoples no longer have to give up their cultural identity and assimilate into the larger society. Like the Indian delegation at the Royal Ontario Museum of Archaeology in 1939, today's native leaders speak for themselves without intermediaries. Dr. McIlwraith would applaud, and so would Grey Owl.

Donald Smith will give the Royal Ontario Museum's Edward S. Rogers Annual Lecture in Anthropology on 1 November. It will be a slide show/talk based on his latest book From the Land of Shadows. The Making of Grey Owl.



PHOTOGRAPHY COURTESY JUDY PATTERSON

In the layered quartz sandstone of the Hurwitz Group heavy minerals are concentrated in the dark layers, and some, such as zircons, can be used for determining the age of rock.

Learning from the Age of Rock

THE CANADIAN SHIELD IS ONE OF the largest exposed Precambrian terranes in the world, providing an ideal location for the study of rocks that may range in age from 1 to nearly 4 billion years. Although the formation of the Earth is calculated at approximately 4.6 billion years ago, no rock from the first 600 million years, the Hadean Era, has ever been found. The rocks of the Canadian Shield are some of the oldest known to geologists.

In 1988 I coordinated a research project with Dr. Larry Heaman of the ROM's Jack Satterly Geochronology Laboratory of the Department of Geology, to study some aspects of two groups of rocks that are found southwest of Rankin Inlet in the Northwest Territories, deep within the Canadian Shield. The Hurwitz Group consists of sedimentary and igneous rocks and overlies the Kaminak Group of mainly igneous rocks. Determining the ages of the Hurwitz and Kaminak groups makes possible a comprehensive analysis of this part of the Precambrian world. Such an analysis can lead to insights into more general aspects of that phase of Earth's evolution.

The determination of the absolute dates of rocks is called geochronology. Whereas geologists can ascertain a relative chronology of rock formation from the Cambrian period (570 million to 500 million years ago) onwards by making comparisons to the fossilized remains of hard-body animals found in the rock, this is more difficult in the Precambrian, a time before the appearance of such animals. Geochronological research requires the dating of either whole rocks or the individual mineral samples found within the rocks. Such research yields the date of crystallization from a magma, molten rock material that cools to igneous rock, or that of metamorphism, a time when the rock was subjected to intense heat and pressure that is usually related to an episode of mountain building.

For the geochronological analysis of the Hurwitz and Kaminak groups, rock samples were taken from various places in the study area. From the underlying Kaminak Group, rhyolites were collected. These are volcanic rocks containing much silica, which resemble granite in composition but have a texture that shows flow. From the Hurwitz Group came layered quartz-rich sandstones and gabbros, dark ig-

neous rocks which intrude the younger sedimentary rocks of this group. The samples were shipped back to Toronto for analysis.

The preparation and analysis of the Hurwitz and Kaminak rock samples took place in the ROM. Zircon and baddeleyite grains were the focus for this study. Both minerals crystallize from magmas and contain trace amounts of uranium. Uranium decays over time, resulting in daughter products, such as lead. The ages of the rocks could be determined by an analysis of uranium to lead ratios. Michelle Moore, a geology research technician in the geochronology laboratory, and I began the preparation of the rock samples with many dirty hours in the rock crushing room, followed by several stages of mineral separation. Dr. Heaman then performed the delicate and demanding tasks of the chemical analysis of the minerals. The Museum's geochronological laboratory and its staff are considered among the world's finest.

Several results were obtained. Zircons in the Kaminak rhyolite offer ages of 2.681 billion years, plus or minus 2 million years. Grains of zircon were also found in the quartz sandstone layers containing heavy minerals from the Hurwitz Group. These grains were eroded; they had been transported much like grains of sand, and then deposited in the sandstone. They are dated at 2.715 and 2.697 billion years. This means that some zircons that are mixed in with the quartz sand were eroded from rocks that were about 2.7 billion years old, about the same age as the Kaminak rhyolite.

It is known from observations in the field that the gabbro intrudes most of the layered rocks in the Hurwitz Group, and therefore the gabbro is the youngest rock. From the baddeleyite grains in the Hurwitz gabbro it was discovered that the gabbro is from 2.09 to 2.24 billion years old. Consequently most of the Hurwitz Group was deposited before that time.

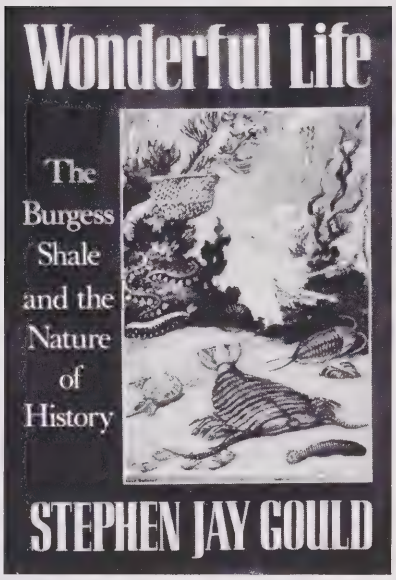
From these results we can construct a picture of the Canadian Shield in the region southwest of Rankin Inlet, as it was more than 2 billion years ago. From the presence of Kaminak igneous rock and our research, we know that near the close of the Archaen Era there was extensive volcanic activity. This was followed by a long quiet period with no volcanic activity. The volcanoes eroded to form the sandstone deposits of the Hurwitz Group, containing grains of zircon eroded from the underlying rocks.

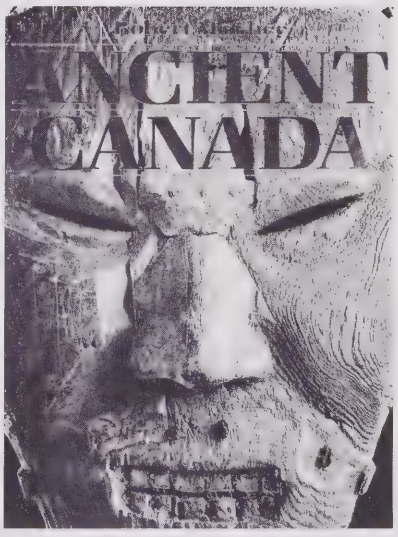
In other parts of the world, geologists have discovered sites showing a similar pattern of transition from a period of extensive volcanic activity to one of nonvolcanic activity and extensive erosion. These sites have dated to the Proterozoic Era (2.5 billion to 570 million years ago). A particular characteristic of the Proterozoic Era was the formation of huge deposits of pure quartz sand, up to a kilometre deep, that covered thousands of square kilometres. It was a time when the processes of plate tectonics caused great continental movement.

Throughout billions of years, continental movement has formed oceans, which are later destroyed. Even now continental shifts are slowly causing the Atlantic Ocean to shrink in size, while the Pacific Ocean is becoming larger. The Hurwitz gabbros may have been part of the volcanic activity that accompanied the creation of the Manikewan Ocean, which once covered Manitoba and Saskatchewan. This great ocean was subsequently destroyed through continental movement between 1.9 and 1.8 billion years ago, long before the existence of the Tethys Sea that covered the middle of the North American continent when dinosaurs first appeared, a mere 250 million years ago. To look at the rich tundra landscape today, it is difficult to imagine how stark it was in Precambrian times.

JUDY PATTERSON
Judy Patterson is assistant professor in the Department of Geological Sciences, Erindale College, University of Toronto.

Wonderful Life
The Burgess Shale
and the Nature of History
Stephen Jay Gould
W. W. Norton
347 pp. $27.95 (cloth)





Seldom are bestselling books published on a subject that has had such a long and continuing connection with the Royal Ontario Museum. Even before Charles D. Walcott, secretary of the Smithsonian, discovered the first fossils from the Burgess Shale site on Fossil Ridge, British Columbia, in 1909, Byron E. Walker (later Sir Edmund, first chairman of the board of the ROM) had collected in 1897 one of the first Burgess Shale "weird monsters" from the famous trilobite beds on nearby Mount Stephen. This was a small spine described in 1899 as *Orthotheca corrugata*, and now is the type specimen of *Wiwaxia corrugata.*

On 1 October 1912 Walcott, on the way back to Washington from his third season of excavation of the Burgess Shale, stopped in Toronto and "called on" Sir Edmund Walker and on Professor Parks, the first directors of the Royal Ontario Museums of Palaeontology and Mineralogy, respectively, and on Sir Edmund Walker. According to his diary, Walcott also "looked thru' the new University Museum." This was the original ROM building, before it was officially opened. Walcott and Sir Edmund subsequently visited each other whenever they were in Washington or Toronto.

In 1975 a ROM field party (only the fourth, including Walcott's) was allowed to collect from the Burgess Shale. Since then, ROM parties have spent six seasons searching for and excavating new localities of Burgess Shale fossils. A seventh season is currently under way. Some of the newly discovered fossils are illustrated or described in *Wonderful Life.*

Gould visited the ROM a couple of times while writing *Wonderful Life.* The first time he sought advice on hiking to the Burgess Shale site, which he visited in August 1987. He also wished to be brought up to date on the most recent Burgess Shale discoveries. The second time he consulted with Marianne Collins, the chief artist for the ROM, who produced 20 original reconstructions of Burgess Shale animals for his book, which make reading it even more enjoyable. On 16 January 1990 Gould lectured on the Burgess Shale to a packed audience in the ROM Theatre.

Since *Wonderful Life* was published in October 1989, it has been on the non-fiction bestseller list in the U.S. and the U.K. In Canada, it was on *Maclean's* list from January to May, and for a couple of weeks was number one. Does this book deserve such recognition? Absolutely!

Wonderful Life begins with an account of how three British scientists, Harry Whittington, Simon Conway Morris, and Derek Briggs, redescribed many of the Burgess Shale fossils, and in so doing, revolutionized our understanding of how life on Earth has evolved over the past 600 million years. Walcott classified the Burgess Shale fossils within animal groups living today. In contrast, by the time they had finished their descriptions, Whittington, Conway Morris, and Briggs had eight specimens they could not assign to any known phylum, and 15 arthropods they could not assign to a known arthropod class.

Gould considers these unassigned forms, and some others still to be described, to represent phyla and classes of arthropods that are now extinct, indicating that there were many more basic types of animals alive 530 million years ago

than there are today. The reduction of animal types to the present situation has been brought about by what Gould refers to as Contingency, that is mass extinctions. Thus, by providing a maximum set of animal blueprints from 530 million years ago for comparison with the reduced number alive today, the Burgess Shale demonstrates that evolution of human beings has taken place contrary to the laws of probability. This startling deduction, based on the demonstrated effect of Contingency, is the source of the book's title taken from the Frank Capra film of the same name.

But just how great was the effect of Contingency? It all depends on how the Burgess Shale animals are classified. Walcott placed them in living groups, which would indicate that the effect of Contingency was slight. Gould puts all of the many "weird monsters," the unclassifiable specimens, into extinct phyla, indicating that the effect of Contingency was great. He has thus challenged evolutionary biologists and palaeontologists to look closely at Burgess Shale and other animals of Cambrian age and attempt to classify them. Upon the broad acceptance of these classifications will rest an understanding of Cambrian life, and the probability of human evolution.

If Gould is right, Contingency must be added to Mutation and Natural Selection as a major factor in the process of Evolution. If he is wrong, then the presently unclassifiable fossils will probably be included in a modified classification recognizing them as ancestral forms or bizarre offshoots of existing phyla. Either way, Gould will have provided a major impetus to changing the view of the evolution and classification of life on Earth.

Gould is an excellent storyteller. In *Wonderful Life* he has managed to weave the many strands of a subject largely unknown to the public into a coherent and pleasing tapestry. However, he also indulges his passions for iconography and historical setting, which, although interesting, are not always relevant. This is particularly true for Gould's criticism of Walcott's "archtraditionalism," which probably had little to do with Walcott's placing of the Burgess Shale animals into extant phyla.

Wonderful Life is fast becoming a classic. Because of its scientific importance, its Canadian setting, and its ROM connection, it is a book that should be in all Canadian natural history and popular science libraries.

Reviewed by Desmond Collins, curator in the Department of Invertebrate Palaeontology, Royal Ontario Museum.

Ancient Canada
Robert McGhee
Canadian Museum of Civilization
175 pp. $29.95 (cloth)

Dr. Robert McGhee is head of the Scientific Section of the Archaeological Survey of Canada at the Canadian Museum of Civilization in

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Ottawa. He is not only an accomplished archaeologist but an excellent writer as well. In *Ancient Canada* McGhee offers a sampling of events that involved specific individuals or societies in prehistoric Canada. The book is in many ways like a series of still photos from a feature-length film.

The selected events, spanning a period of 15,000 or 20,000 years, are organized into 16 chapters. Three introductory chapters describe the peopling of the New World and the earliest cultures in Canada, and include illustrations of material from the Yukon and Ontario. Chapters on the Arctic, the Northwest Coast, the Plains, Ontario and Quebec, and Labrador follow. These are arranged roughly chronologically from the earliest events to the latest. Chronological order is logical from an archaeological perspective; it may at first be confusing to general readers expecting a geographical presentation (i.e. one that moves from coast to coast). A final chapter, which McGhee refers to as tabloid archaeology, discusses Canadian and New World prehistory in general with respect to popular views about lost continents, lost or wandering peoples from the Old World, and even visitors from outer space.

In addition to the main text of each chapter there are a number of short illustrated essays that develop related topics in more depth. The chapter on Paleo-Eskimos, for example, contains an essay on the origin and spread of the bow and one on Dorset art. Similarly, essays on the totem pole and woodworking in prehistoric times complement the chapter on Northwest Coast architecture and society. The short essays expand the scope of the book considerably and often help to place Canadian prehistory into the broader context of world prehistory.

The book is beautifully illustrated with a remarkable range of maps, artifact and excavation photographs, line drawings, archival photographs from the ethnographic record, artists' conceptions of scenes from prehistoric life, and in the final chapter a two-page time chart in colour, showing major events in Canadian and world prehistory. Readers have the pleasure of finding at least one illustration with every turn of the page.

In his final chapter, McGhee makes the point that there would be fewer misconceptions about prehistoric times if archaeologists would make more of an effort to provide information about their discoveries and work to the general public. He is right, of course. I've noticed when asked to recommend books for general reading that there are few. Robert McGhee's book is, therefore, a welcome addition, and I strongly recommend it to those interested in the Canadian component of our collective human heritage.

Reviewed by Dr. Peter Stork, curator in the Department of New World Archaeology, Royal Ontario Museum.

Cheap Shot at the Christian Faith?

I was appalled by the cheap shot at the Christian Faith I encountered in David M. Pendergast's article on the Maya in your spring 1990 issue (*Rotunda* volume 22 number 4), "The Maya, lacking the Christian excuse to play fast and loose with the environment..."

Lynne White's original (and quite unfounded) accusation against the Bible as being to blame for modern environmental attitudes has been unthinkingly digested by religiously ill-educated secular humanists and is being endlessly regurgitated in supposedly scholarly compositions such as the one by Pendergast.

Anyone with even a smattering of familiarity with the teaching of Jesus and of the Bible generally knows that it portrays Man as a steward who is to give an account of his stewardship to his Creator.

The attitudes which have given rise to our modern environmental problems may be more accurately traced to the Enlightenment, which —while it conferred intellectual benefits—led to the development of Secularism, or the organisation of life with God left out. Man now sees himself as accountable to no one but himself. It is this attitude, which has its roots in the thought of philosophers like Hegel and Marx who exalted man above nature, which has made modern man unafraid to rape the environment.

Pendergast appears to adopt a sentimental preference for Mayan paganism over Christianity, but is he really ready to embrace the religious context out of which Mayans managed their forest environment? Since he seems unquestioningly to

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Simpsons

go along with his contemporaries' glib rejection of his own religious context it may be that he is really more secularist than pagan.

In any case, the case he attempts to make for the success of Mayan land use is totally contradicted by an extensive treatment of the same subject in the *National Geographic* for October 1989.

CANON ROBERT C. TUCK
KING'S COUNTY ANGLICAN PARISH
PRINCE EDWARD ISLAND

Dr. Pendergast Replies

I am sorry that Canon Tuck is offended by what I wrote. Uninfluenced by White's views, which I have not seen, I base my assessment of the role of Christian belief in environmental destruction on observation of Christian practice. My observations have been given support by statements of individual Christians regarding the dominion over the Earth that is granted human beings by the Bible. Furthermore, it has been Christians (however misguided they may have been regarding what their religion teaches them) who have been the principal agents of forest destruction in the Maya areas since the 16th century.

There is indeed a stewardship that Christians must discharge, but it is far from clear how an individual's efforts will be weighted. The Bible speaks extensively about sin and punishment, but provides no guidelines regarding what constitutes a sin in the exercise of one's dominion over nature. On which side would the balance rest, for example, if a person were to establish a papermill in Belize and thereby put food on the tables of many hungry families, but in the process denude a major section of the country's landscape and foul its waters?

I do not believe, and did not imply in the article, that we should reject the Christian belief system in favour of Maya religion. We would find much of ancient Maya religious practice abhorrent, and much of the belief system irrelevant. I do believe, however, that we have something to learn from the ancient Maya, and from others, regarding our attitude towards the place of humankind in the natural world.

Finally, I am not quite sure what refutation of my statements appear in the October 1989 issue of *National Geographic*. I made no case for the success of modern Maya land use; it is often destructive. Today's Mayas, though they may retain some of the ancient respect for the land, are separated from the belief system of their ancestors by an unimaginably vast gulf. A large part of that gulf consists of the fact that they are Christians, as their ancestors have been for more than four centuries. A great many Mayas are now driven by aspirations and demands created by the increasingly voracious appetites of the developed world. It is those appetites that we must reduce if the world is to remain habitable. I believe that in addition to all the laudable efforts by Christians and others, a lesson drawn from ancient Maya religion might bring us a step nearer that goal.

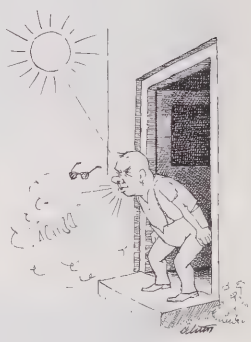
JAY INGRAM

The Shining

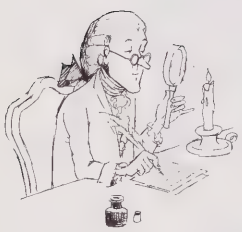
1. For more than 300 years, scientists have debated the nature of light. Is it made up of waves or of tiny particles?

2. Only one of the seven wonders of the ancient world (the original list of seven wonders was possibly first recorded as early as 200 B.C.) was actually useful, and light was crucial to its function. What was it?

3. A report in the summer of 1989 showed that the human biological clock could be reset by an appropriately timed series of exposures to light with the same brightness as early morning daylight. In what situations does this discovery promise to be most useful?



4. Sneezing carries with it a voluminous folklore, including the claim that some people feel an uncontrollable urge to sneeze when exposed to sunlight. Is there any truth to this?



5. Most of us, at one time or another, wonder why the sky is blue. But we seldom ask the corollary: why is the night sky dark? It's not as silly a question as it sounds. If the universe is full of stars in every direction, why doesn't their combined light make the sky blindingly bright, day and night?

THE ANSWERS

1. Light is both waves and particles. Isaac Newton championed the idea that light was made up of a continuous stream of particles or, as he called them, corpuscles. Yet at the same time Newton realized that some phenomena exhibited by light could be better explained if it were a pattern of waves. But his theory of corpuscles prevailed for a century, until the early 1800s, when the English scientist Thomas Young showed that if a beam of light travels through two narrow vertical slits, a series of alternating dark and light vertical bands forms behind the slits on a screen. This is most easily explained if light is travelling in waves: the dark bands then represent places where two wave crests coincide and reinforce each other, the light bands where troughs come together. It's a different version of what you would see on the surface of a pond if two pebbles were thrown in and the resulting ripples came together.

This was by no means the end of the notion of light as particles. Albert Einstein actually won his Nobel prize, not for his theory of relativity, but for his work showing that light comes in packages of energy called quanta. Today both ideas have come together—the particles of light, called photons, behave in wavelike ways. In the uncertain and peculiar world of quantum mechanics, the dark and light bands seen in Thomas Young's experiment are understood to be the result of each individual photon's possessing wavelike properties. Experiments have shown that although each single light particle appears to arrive at a random location on the screen, after the arrival of thousands of such particles, the alternating light-dark pattern begins to appear. It's just another example of how quantum phenomena behave differently from what we might intuitively expect.

2. The lighthouse at Pharos. All the other wonders were aesthetic. The lighthouse at Pharos protected sailors from running aground in the treacherous waters around the harbour at Alexandria. With a height of 122 metres or more (taller than any lighthouse today) it could apparently be seen from a distance

of 56 kilometres, although one claim stated it was visible a day's sail away, which might be as much as three times further. During the day a column of smoke marked the lighthouse; at night the light from huge fires fuelled by resinous wood was reflected out to sea by mirrors of copper or silver.

The building itself looked more like a 1930s skyscraper than a lighthouse. The base was about the height of a 22-storey building, and contained up to 300 rooms. The second level was an octagon, about 11 storeys high, which in turn was surmounted by a 7-storey cylinder crowned by a domed shelter. A statue of Poseidon stood on top. Work was begun on the lighthouse in 299 B.C., and most of the structure was destroyed in an earthquake in A.D. 1375. Some of the remaining original stone was incorporated into a castle built on the site in 1477 by the Sultan Qait Bey.

Some stories have suggested that the mirrors were so powerful they could redirect the sun's rays and set fire to attacking ships. This is another version of a feat originally attributed to Archimedes, who is supposed to have arranged soldiers on land holding reflective shields in a way that would ignite Roman ships attacking the island of Syracuse. Researchers have used landbased mirrors to set fire to experimental dinghies anchored offshore, but focusing sunlight on a moving warship sounds like a much more difficult proposition.

3. Jet lag or shift work. A group of American scientists demonstrated in 1989 that they could alter the timing of a person's biological clock dramatically by exposure to light. A group of young men went through three twenty-four-hour cycles, each cycle comprising eight hours of darkness, eleven hours of normal indoor light, and five hours of bright outdoor light. Depending on the timing of the bright light, some of the subjects had their body time shifted by as much as twelve hours. The most sensitive time was when the body temperature was lowest, which usually occurs two or three hours before one wakes up in the morning. Charles Czeisler, the director of the study, claimed that three exposures were sufficient to reset a patient's clock: the first dose disorganizes it, the second obliterates all traces of the original timing, and the third sets up the new time.

The researchers had specific advice for coping with jet lag. A dose of bright light before the low-temperature point in the early morning will move your clock forward—exposure after that point will change the clock back. So if you're flying from Toronto to London, you should get some exposure to bright light before 3:00 or 4:00 a.m. Toronto time. If you're flying to Hawaii, it's better to get your light dose after your low-temperature point.

4. Yes it is true—it's called photic sneezing, and it usually involves a series of short sneezes upon exposure to light. Any bright light can do

it, but the sun is particularly effective, probably because stepping outside into the sunshine is the only action during the day which exposes you to a sudden bright light. Apparently light stimulates nerve pathways that are shared by the sneezing reflex, and the cascade of events leading to sneezing begins. Signals go out to the phrenic nerve to lower the diaphragm, the ribs expand, the roof of the mouth rises, and suddenly air is driven out with such force that bacteria-laden droplets emerge travelling at more than 30.5 metres per second. In fact sneezes can actually fracture bones in the nose, the sinuses, and the middle ear.

People susceptible to photic sneezing make up anywhere from 11 to 36 per cent of the population, and doctors have noticed that it is a dominant genetic trait. But does the medical profession take it seriously? You wonder, when one paper on the subject is titled *ACHOO Syndrome,* ACHOO standing for Autosomal Dominant Compelling Helio-Ophthalmic Outburst.

5. This puzzle is best known as Olbers' Paradox, even though Heinrich Olbers, a 19th-century astronomer, was by no means the first to pose it—the debate can be traced back to the ancient Greeks.

In a finite universe there would be no problem; the dark parts of the night sky would just be the unlit backdrop beyond the edge of the universe. But in an infinite universe, then no matter in which direction you look, eventually a star will be in your line of sight. Yet, although the universe is infinite, if there were always a star in your line of sight, the entire sky would shine at all times with the brightness of the surface of the sun. Obviously there is something happening to prevent this. Heinrich Olbers suggested that huge interstellar clouds absorbed the light from distant stars, preventing it from ever reaching Earth. But it was soon pointed out that those clouds in turn would gradually heat up until they too were radiating light.

The real reason the night sky is dark, according to present-day theories, is that the universe just isn't old enough to fill our whole sky with light. Given the current estimates of 15 billion years or so for the age of the universe, no source of light more than 15 billion light years away from Earth has yet contributed to the brightness of the sky. No light from that distance has had time to reach us yet. In fact it's a good guess that stars and galaxies may have formed only about 10 billion years ago, so the total number of light-contributing stars and galaxies is probably smaller yet. For a while it was argued that the weakening ("red-shifting") of light caused by the expansion of the universe also acted to dim the levels of starlight reaching Earth, but Paul Wesson at the University of Waterloo, among others, has pretty well laid that idea to rest. Age is the solution to Olbers' Paradox.

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